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## Universal Radial Drilling Machine.

We illustrate herewith the latest and improved pattern of Universal Radial Drilling machines by the Niles Tool Works of Hamilton, Ohio.

This type of radial drill has been manufactured by this company for the past twenty years. It has been found very serviceable and well adapted for all kinds of work, usually done upon machines of its class, and has been improved from time to time for the purpose of keeping it up to the demands of the times.

As is well known to mechanics who have used drills of this type, one of the main difficulties attending their use is the deflection of the arm when the drill head is run out to, or near the end of the arm. A long arm unsupported will spring more or less under heavy pressure, and great care must be taken in its construction to reduce the deflection to a minimum, so as not to affect the work. In order to accomplish this, the arm itself must be of the stiffest form possible, to resist the upward strain, as few joints as possible must be introduced, and the sleeve surrounding the column supporting the arm must be very long and well fitted—features which have been attended to in this machine. The arm is in form similar to a box girder, and is made in one piece, the sleeve surrounding the column forming a part of the same, and a heavy web on the upper side resists the upward strain.

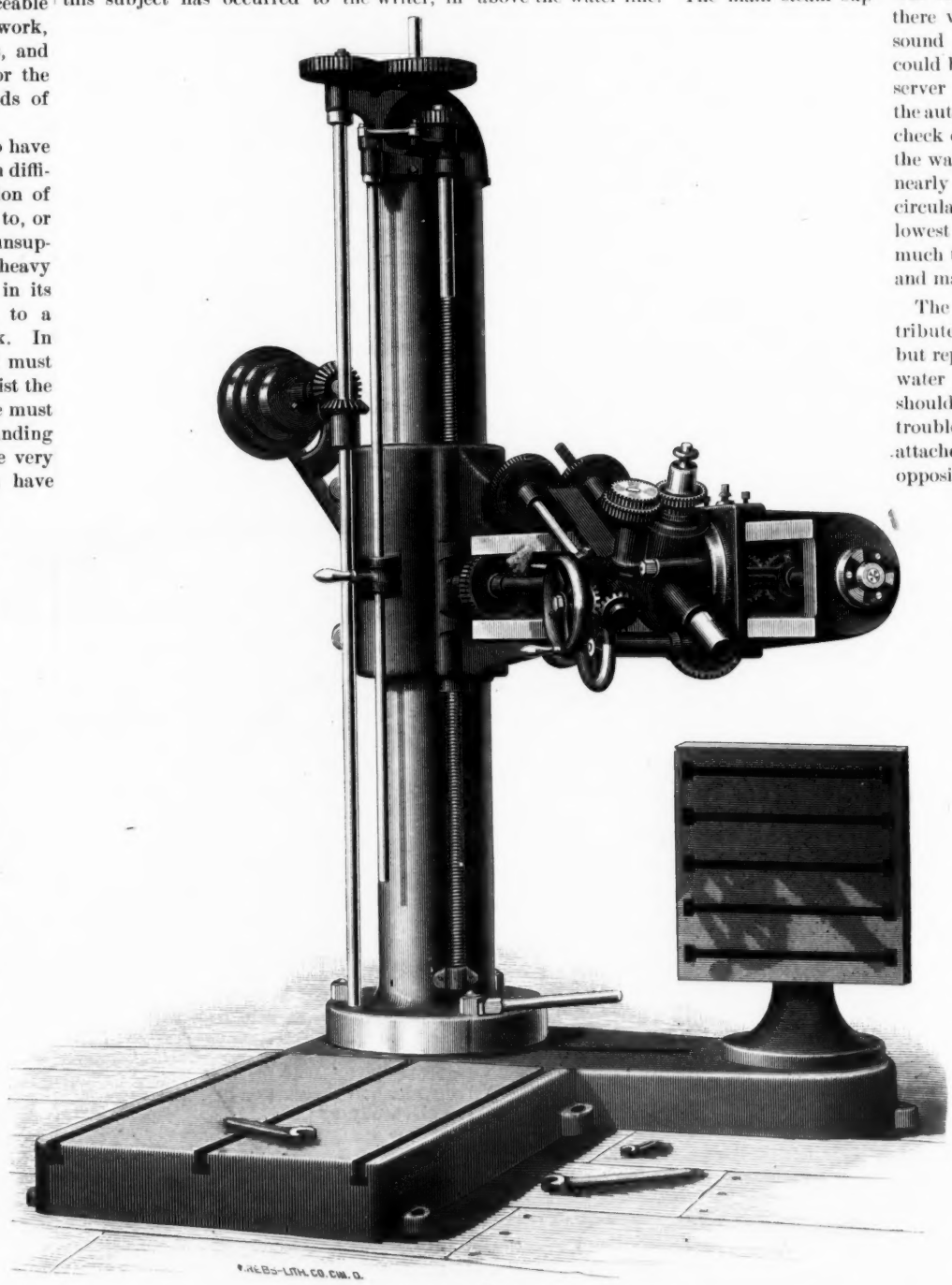
It will be noticed that the arm is not made to rotate in a horizontal direction—a feature which makes a joint between the sleeve and arm necessary, and when the arm is turned in that way so as to bring the drill spindle horizontal or nearly so, the strain imposed by the feed is in a direction tending to twist the column, and in which there is no metal so disposed as to effectually resist it; considerations which have led the makers to dispense with this feature, some of the advantages of which are secured by the adjustable table.

The column of the machine is set upon rollers in the base, which enable the operator to handle the machine with the greatest possible ease.

The drill head is so constructed that it is in perfect balance, and the bolts may be loosened without endangering either the machine or the operator. The head can be moved by a hand wheel on the head itself, making it unnecessary to go to the end of the arm for that purpose.

The drill is back-geared, giving eight changes of speed, and has a power feed with three changes.

Two sizes are made, the No. 1 having an arm five feet long, and a column seven feet four inches high, greatest distance from base-plate to end of spindle, five feet three inches, greatest distance from center of column to spindle four feet six inches. The No. 2 has an arm six feet long, column eight feet three inches high, greatest distance from base-plate to end of spindle five feet seven inches; greatest distance from center of column to spindle, five feet seven inches.



UNIVERSAL RADIAL DRILLING MACHINE.

## The Effect of Circulation in Steam Boilers on the Quality of the Steam.

BY GEO. H. BARRUS, BOSTON, MASS.

A PAPER PRESENTED AT THE NASHVILLE MEETING OF MECHANICAL ENGINEERS.

A somewhat remarkable experience upon this subject has occurred to the writer, in connection with a small boiler used for steam heating.

The boiler was of the vertical type, and consisted of a plain shell (without a water leg) 40 in. in diameter and 48 in. in height. It contained 115 2-in. tubes 4 ft. long. The boiler was supported by a brick furnace, which contained a grate 33 in. square, placed 24 in. below the lower head. A smoke bonnet, having a side flue 12 in. in diameter, carried the gases to a brick chimney close by, which was 40 ft. high. The side flue contained a damper operated by an automatic regulator set to close at a pressure of about 5 lbs. The shell was covered with fossil meal.

The heating apparatus was constructed on the low-pressure gravity return system. The total extent of radiating surface amounted to 900 sq. ft. The lowest point of this surface was at a horizontal distance of 100 feet from the boiler, measured along the return pipe, and this point was 18 in. above the usual water line. The highest point was 14 ft. above the water line. The main steam supply pipe was a 2½-in. pipe, and led off from the upper head of the boiler, near one side. The main return pipe was a 1½-in. pipe, and at a point beyond the check valve it was increased to two inches, and entered the boiler through the bottom head. A short piece of the pipe and the elbow were exposed to the heat of the furnace.

The upper ends of the tubes in the boiler were provided with cast-iron ferrules, the openings through which were ¾ in. in diameter.

Soon after the plant was set to work, difficulties began to be encountered in the working of the boiler and in the return of the water from some of the pipes. The action was as follows: The boiler was filled to such a point that with a low fire the level of water stood at the top of the glass. As soon as the fire was started up and steam began to form, the water gradually fell, and by the time the whole plant was in normal action the water had reached the bottom of the glass, which was some 12 in. below. At the same time there was ample evidence of priming. The sound of rushing water in the main pipe could be distinctly heard, even when the observer stood at some distance away. When the automatic damper closed and a momentary check occurred in the production of steam, the water came back at a rapid rate and soon nearly filled the glass. The radiators and circulations farthest from the boiler and lowest in elevation filled with water, and much trouble arose in freeing them of water and making them heat in a proper manner.

The priming of the boiler was at first attributed to the presence of oil in the water, but repeated blowing off and change of the water produced no beneficial result, as it should have done if this was the cause of the trouble. Two additional steam pipes were attached, each a 2-in. pipe, and applied to opposite sides of the boiler as high in the shell as possible. Each of these pipes entered as far as the tubes, and the upper part was cut away so as to draw steam from above, rather than from below. These were both connected to the main supply pipe. In spite of the distribution in the points of discharge which these pipes effected, there was no abatement of the principal difficulty.

Under advice from the chief inspector of a prominent boiler insurance company, the boiler was treated to a large dose of soda. This penetrated the whole system of pipes and radiators, and worked for several days. The boiler was then blown off and refilled with fresh water. Even this treatment failed to give relief, although the priming appeared to be less serious while the alkaline liquor was in use.

Finally a suspicion arose in the writer's mind that the priming was due to improper circulation of the water. The tubes in this boiler were laid out inside a circle 32 in. in diameter. There was a clear space outside the tubes all around 4 in. in width. It was thought that an increase of this space might improve the circulation, and the plugging up of the outer row of tubes was contemplated. Before trying this plan, however, it was thought that the same result might be effected by removing some of the ferrules in the center of the boiler, so as to centralize the heating effect of the fire, thereby increasing the rapidity of ebullition at the center, while reducing it at the circumference. Examination revealed the fact that these ferrules, as before stated, had openings ¾ of an inch in diameter, these openings aggregating in area 0.35 sq. ft., which bears a ratio to the grate surface (7.56 sq. ft.) of 1 to 21.6. This ratio, it must be admitted is too small for efficient boiler work. Accordingly, 36 ferrules near the center were removed, and the collective area of the openings increased to 0.84 sq. ft.,

which bears a ratio to the grate surface of 1 to 9.

The effect of this change was instant. The priming disappeared at once. The water line became nearly constant, the extreme variation being reduced to 2 in. There was no further difficulty with draining and heating of the pipes and radiators, and the whole apparatus worked from this time on with perfect satisfaction.

It appears that the small area for draft that existed when the ferrules were all in use, caused such a distribution of the heat through the whole number of tubes, that an active ebullition occurred through the whole body of water. This interfered with the natural circulation of the water, and the result was a commotion which caused the water to boil over into the steam pipe. The concentration of the heat at the center of the boiler, in the manner pointed out, changed this disordered condition, produced an easy circulation, and furnished a complete remedy for the whole trouble.

The amount of water-heating surface in the boiler is approximately 120 sq. ft., and this suffices to warm the building in a proper manner in the coldest weather. The building is a church, having wooden walls, and it contains some 160,000 cubic ft. of space.

## Abstract of Papers Presented at the Nashville Meeting of the Mechanical Engineers.

L. S. Randolph presented a paper on "Strains in Locomotive Boilers." He laid stress on the fact that has troubled railroad master mechanics for years, viz.: the difference in expansion between the shell and the fire box sheets. Following this up, he shows the effect of unequal expansion on the boiler generally, concluding as follows:

The writer's experience has shown that in nearly every case the failure of boilers is due, except where corroded by bad water, to failures of metal, from repeated straining beyond the elastic limit by difference in rates of expansion and contraction.

So far the use of large easy curves for flanges and very soft metal throughout the boiler are the only methods that have met with anything like success in overcoming this difficulty. Corrugated flues and fire boxes would probably save a great deal of the trouble, but they are open to objection, especially where the coal used contains much sulphur, on account of corrosion caused by soot and ashes lying in the corrugations.

"The Mechanical Significance of Viscosity Determinations of Lubricants" was the title of a paper presented by James E. Denton. In this the author described different viscosometers—that is, instruments for measuring the viscidity of oils. The author detailed experiments in lubricating the slide of an upright engine with different qualities of oil, from which the following conclusions were reached:

From the experiments with the engine slide described, it appears that the possible saving in the oil consumption necessary for minimum wearing away of the rubbing surfaces, due to the difference in viscosity, proves that the most economical lubricant is the oil of the greatest viscosity, which will permit the oil to be fed, wherever the loss of power in friction is an element of inferior importance, as is the case in all heavy machinery.

"Notes on Warming Railroad Cars by Steam" was presented by Wm. J. Baldwin.

In this paper the author detailed some experiments on the Long Island Railroad, the experiments being made for the purpose of determining the quantity of steam required for warming a car; also to determine the rate of cooling of a car after the steam was shut off. The author says:

The deductions to be drawn from the experiment in general is (1) that two square feet of surface per running foot of car is more than ample for warming. (2) That each square foot of surface requires heat equivalent to about two heat units for each degree the air is colder than the heater.

"A New Method of Inserting Crank Pins" was the title of a paper by C. C. Collins.

That part of the pin which enters the crank is turned taper, smallest at the back end, and the hole in the crank is taper the other way (largest at the back), so when the pin is inserted, there is an annular wedge-shaped space all around it, which is filled by a split ring, which is taper on the outside, to fit the hole in the crank, and inside, to fit the pin. This wedge ring is drawn into its place by an internally threaded ring or nut, which screws on to the end of the pin, so that when it is tightened it draws the pin against its shoulder at the same time that it tightens the annular wedge.

"Automatic Regulator for Heating Apparatus" was presented by J. T. Hawkins. The writer favors hot water heating, but makes the statement, which will be recognized as a fact, that there has not heretofore been any means of automatically regulating the heat within reasonable limits. He then goes on to describe an apparatus which he has devised; it is a helical coil thermostat surrounding the return pipe from radiator. This thermostat is made of two strips of metal, having widely different co-efficients of expansion, soldered or brazed together. The more expansible metal is on the inside, and the less expansible outside. By the use of suitable levers and connecting mechanism this is made to govern the damper. Of this the author says:

In this construction it will be obvious that the expansible helix, having the more expansible metal exposed to the fluctuations of the temperature of the pipe within it, while the less expansible one is in contact with the surrounding air, and therefore only partially heated by conduction from the inner one, will undergo a considerably greater straightening or unwinding for a given elevation of temperature of the pipe within it than if it were merely immersed wholly in the medium whose variation of temperature was to operate upon it, as with the ordinary thermostat.

The helical thermostat is shown as surrounding a return pipe, but it will be equally efficient, and is generally most desirable, if placed upon an ascending or delivery pipe; the only difference being that in one case the regulation is made to conform to the fluctuations of the temperature of the water passing from the heater to the radiator, and in the other that of the water returned from the radiator to the heater.

As in the gravity, or open hot-water system, there is generally required to be a separate return and delivery pipe connecting each radiator with the heater, it would be desirable to attach this apparatus to either the delivery or return pipe of the principal radiator in the house, so that the temperature of the entire house will be governed by that of its principal apartment.

"Memoranda on the Performance of a Compound Engine" was the title of a paper by Geo. H. Barrus. Descriptive of this engine, the paper says:

The diameter of the high pressure cylinder was 26 inches; that of the low pressure cylinder, 48 inches, and the stroke of both was 60 inches. Steam was furnished by Harrison sectional boilers, after first passing through an ample sized steam drum. The exhaust steam was condensed in a surface condenser, the circulating water for which was supplied by a duplex steam pump having steam cylinders 9 inches diameter, water cylinders 10 inches diameter, both 12 inches stroke, which also exhausted into the condenser. The engine was fitted with a connected air pump which discharged the condensed water into a hot well consisting of a large rectangular tank. The intermediate receiver was drained by a trap which discharged into the hot well. The engine was of the Corliss type. The governor operated on the cut-off of the high pressure cylinder. This had no connection with the cut-off of the low pressure cylinder, which was arranged so as to be fixed at any desired point.

The engine was run at 52.3 revolutions per minute, and developing 606 indicated horse-power, with boiler pressure 94 lbs.; the consumption of steam was 16.28 lbs. per indicated horse-power per hour. For determining the steam used, the condensed water discharged from the surface condenser was measured.

In "River Practice of the West," Jno. M. Sweeney gives an interesting account of the construction and machinery of Western river boats. Speaking of the engines of these boats, he says:

Probably no single feature of the engine has received so much unfavorable criticism as the lever valve gear; while in reality it is better fitted for the requirements of the service than any other, and in support of this statement it may only be necessary to call the attention of our engineers, who are of the opinion that the method is very crude and primitive, to this: these boats are very raftlike, limber; overloading at any point will distort their shapes; "tight on their chains" when without load; "slack on their chains" when loaded; so throughout the process of loading and unloading, one or the other effect is constantly going on; unequal conditions as often occur; these in turn perceptibly vary the distances between the center of the main shaft and "rock shaft." Now the lever valve gear allows this variation without seriously affecting the timing of the valve movement; no other form of valve arrangement gives this very necessary quality of stretching. The writer was at one time employed to place on a side-wheel boat a pair of engines 24" diameter, 48" stroke, slide valve. The valve gear was very carefully made and adjusted; a stationary link with shifting block was used; engines indicated with excellent results; angularity of connecting rod even was adjusted—something probably never before undertaken on a boat of like class. On first trials, and after going into active service, these engines gave every satisfaction, but soon began to cut capers, refused to "handle" properly, hung on centers, and would not "back," particularly when the momentum of the boat was on ahead. An examination showed serious derangement of the valve timing, due to incorrect length of eccentric rods. A readjustment of the rods relieved the difficulty, but it became necessary to make changes in the lengths of the rods almost daily, covering a period of about 90 days, when, the river becoming too low, the boat retired from service. Upon the resumption of navigation some 40 days later, the engine would not turn over until a radical adjustment of the rods was made, and when corrected they were found to be in nearly their original position, and the total change of the length of each rod was $1\frac{1}{8}$ inches, the distance from the center of main shaft to the link being about 14 feet. This was an exceptional case; a combination of circumstances, a very light boat, the link suspended just at the point where the greatest variation occurred, made it so; but it shows what may and does happen to such valve gears applied to the class of boats under discussion.

In "A Plea for the Printing Press in Mechanical Engineering Schools," John T. Hawkins reasons strongly in favor of instruction in that direction. Amongst other pertinent things he says:

The writer feels—and his experience sustains him in it—that the printing press has received too little special consideration or study at the hands of our professors and instructors in mechanical engineering, and that, with greater attention given, and more importance attached to it, they would be likely to open up an extensive field which the graduate may profitably enter, and from which he is now, in a great degree, excluded, for the reason that the printing press, as one of the most prominent specialties in mechanical engineering, is given little, if any, more attention at school than is involved in the study of the more abstract subjects which he may subsequently apply to it, if opportunity offers.

A graduate, entering an establishment in which steam, electric, hydraulic and textile machinery, or even such as hoisting, crushing, and grinding machines and machine tools are produced, has the advantage of already having some knowledge of what may be called the technics of the particular branch he has adopted; but the printing press manufacturer finds none so well prepared to commence in his field, because of the lack of consideration given it as a special study, while probably a more important branch, and involving the refinements of mechanical study more than any above-mentioned, with the exception of the steam engine and electricity. The writer believes that the manufacturer of printing machinery, in common with the young mechanical engineer graduate, suffers to-day because of the above facts, and that the printing press is losing much of the talent fostered and acquirements gained in our best mechanical schools, because of the comparatively cold shoulder it receives as a desirable branch of special study by them.

*Building*, in referring to the manufacture of sash weights from scrap tinned iron, old cans, etc., after noting the difficulty in melting such scrap safely, concludes: "The sash weights produced [from scrap] are of a superior quality." There is an opinion that the quality of sash weights is measured—outside of their form and the convenience for attaching the cord—by their avoirdupois. Just what the tin scrap of which they are made has to do with this is something that *Building* should explain.

A somewhat amusing discussion is at present going on in the columns of our English contemporary, *Engineering*, between some Canadian and English engineers, regarding the comparative merits of American and English locomotives.

In Canada, some of the locomotives are imported from England, and many from the United States, and consequently Canadian engineers have excellent opportunities of judging of the comparative merits of the machines from actual experience with both, under the same conditions. The natural result is that they favor the American design, and the amusing feature of the discussion comes in from the fact that the Englishmen, knowing almost nothing about the American engines, and constantly revealing that fact in their communications, yet persist in their efforts to convince their colonial compatriots that the American locomotive is all wrong, and that the mother country is the only proper place to look for locomotives—efforts which seem to result in absolute failure.

A few years ago there was considerable stir in the direction of steam street car motors but the (then) coming electric motor put them in the shade. Now it looks as if the steam car was to have its day again. As a matter of fact, the steam car has never had a fair trial, and there are many who think it is yet to be the popular surface motor.

The fifty-first meeting of the Institute of Mining Engineers will be held at Birmingham, Ala., beginning Tuesday evening, May 15.

## Practical Drawing.

By J. G. A. Meyer.

FIFTIETH PAPER.

449. So far, all our auxiliary lines, such as ($h_2\ i_2$, $h_4\ h_5$), ($k_2\ l_2$, $k_4\ k_5$), in Figs. 330, 331, employed for finding points such as $h_4\ h_5$, in Fig. 330, have been straight lines. But when we take up surfaces of a more complex nature, as we now propose to do, we may often have to employ curved lines; or, more precisely speaking, arcs and circumferences of circles for auxiliary lines.

In Art. 25 we see that surfaces are divided into two classes, namely, plane and curved surfaces. Let us now consider how, according to descriptive geometry, these surfaces can be generated and classified.

450. Surfaces are generated by a line moving according to some mathematical law. (See Art. 292.) This line, which, by its motion, generates the surface, is called the generatrix; and a line of the surface which coincides with any one of the positions of the generatrix is called an element of the surface.

Two elements, one of which corresponds to, or coincides with, the generatrix in any position, the other coinciding with the same generatrix in the next position which the generatrix will take while generating the surface, are called consecutive elements.

451. In practice, as well as in descriptive geometry, surfaces may be divided into four classes:

1st. *The Plane Surface.*—This surface is generated by a straight line $C\ D$, Fig. 322, moving along another straight line $A\ B$, the straight line $C\ D$ always continuing to be parallel to itself, as indicated by the straight lines $C_2\ D_2$, $C_3\ D_3$, etc.

Or, in short: A plane surface, or plane, is that which is generated by a right line moving along another right line and continuing parallel to itself.

2d. *Single Curved Surface.*—This surface may be generated by a straight line $C\ D$, Fig. 333, moving along a curve $A\ B$, in such a manner that any two of its consecutive positions shall be in the same plane. Thus, if we consider the lines $C\ D$, $C_2\ D_2$, and $C_3\ D_3$ to represent consecutive or successive positions of the generatrix, the lines $C\ D$, and $C_2\ D_2$, must lie in a plane and $C_2\ D_2$, and $C_3\ D_3$, in another plane, and so on. Again, if we consider the lines $A\ B$, $A\ B_2$, $A\ B_3$, in Fig. 334, to represent the consecutive positions of the generatrix, the lines $A\ B$, and $A\ B_2$, must lie in a plane, and the lines $A\ B_2$, $A\ B_3$ in another plane. Hence we have the following definition:

Single curved surface is that surface which is generated by a straight line, having its consecutive positions in the same plane, and moving according to some fixed law. According to this definition, cylindrical and conical surfaces belong to this class of surfaces.

3d. *Double Curved Surfaces.*—These sur-

faces can only be generated by curves. Thus, the curve *A B C*, Fig. 335, or *D E F*, Fig. 336, moving according to some fixed law, will generate double curved surfaces. Hence double curved surfaces are those which are generated by curves.

4th. *Warped Surfaces.*—These surfaces are generated by a straight line moving in such a manner that any two consecutive positions of the generatrix are not in the same plane.

452. *Surfaces of Revolution.* Surfaces of revolutions are formed by a straight or a curved line revolving about another straight line, called the axis, in such a manner that every point of the moving line generates the circumference of a circle. The centers of these circles will, of course, be in the axis, and the plane of the circles perpendicular to the axis.

The surfaces generated by the revolution of the circle, the ellipse, the parabola, and the hyperbola about their axes, are called respectively the surface of the sphere, of the ellipsoid, of the paraboloid, and hyperboloid. (Davies' Descriptive Geometry.)

453. From the foregoing definitions we see that a surface of revolutions will either be a single curved or a double curved surface; but it must also be noticed that single curved or double curved surfaces will not always be surfaces of revolutions.

In practice, we have generally to deal with surface of revolution, and this class of curved surface will enter into nearly all the following problems.

454. The distinguishing characteristic of any single curved surface is that it may be developed or rolled out upon plane. This characteristic a double curved surface does not possess.

### PROBLEM 65.

455. *To find the intersection of a surface of revolution, or we may say a solid bounded by this surface; a given plane and practical application of the same.*

Let Fig. 337 represent the vertical, and Fig. 338 the horizontal projection of a surface of revolution, *A B* the ground line, and $k_2\ l_2$ (Fig. 338) the given plane parallel to the vertical plane of projection; it is required to find the intersection of the curved surface and the given cutting plane $k_2\ l_2$.

The surface of the given solid is formed by the straight line *a c* (Fig. 337) and the curved line *a p e* revolving around the line $e\ e_3$; this line is the a xis; the straight line *a c* and the curved line *a p e* make up or form the generatrix of the surface of revolution. Consequently we may consider that the given surface of revolution consists of two parts, namely, the single curved surface generated by the straight line *a c* revolving around the line $e\ e_3$, and the double curved surface generated by the arc *a p e* revolving around the same axis $e\ e_3$.

Through the point *a*, the junction between the straight line *a c* and the curved line *a p e*, draw a line *a b* parallel to the ground line *A B*. The line *a b* will be the junction between the single and double curved surfaces. Through the points $k_2$, $l_2$ (Fig. 338) that is, the points in which the cutting plane $k_2\ l_2$ intersects the circumference $k_2 f_2\ l_2$, draw vertical lines $k_2\ k$, $l_2\ l$ cutting the lines *a b*, *c d* which limit the height of the cylindrical surface (Fig. 337) in the points $k$, $k_3$ and $l$, $l_3$; the lines $k\ k_3$ and $l\ l_3$ will be the vertical projections of lines of intersection of our cylindrical or single curved surface and the cutting plane. It now remains to find the lines of intersection of the double curved surface and the plane.

Through the center $e_2$ in Fig. 338, draw the diameter $a_2\ b_2$ parallel to $k_2\ l_2$; from the center $e_2$ describe a circle $r_4\ r_6\ r_8\ r_{10}$ tangent to the line $k_2\ l_2$, cutting the diameter $a_2\ b_2$ in the points $r_6\ r_{10}$. Through the point $r_6$ draw a vertical line, cutting the arc *a p e*, Fig. 337, in the point *r*. Through *r* draw a line $r\ r_3$ parallel to the ground line, and cutting the line $e\ e_3$ in the point $r_5$. Divide the distance between the point $r_5$ and the point *g* in which the line *a b* intersects the line $e\ e_3$ into any number of equal parts, say three, and through the points of division $p_5\ o_5$ draw horizontal lines $p\ p_3$, $o\ o_3$ terminating in the curved line *a e b*. With a radius equal to $p\ p_3$ describe from the center $e_2$ (Fig. 338) the circle $p_4\ p_8\ p_{12}$, cutting the line $k_2\ l_2$ in the points $p_4$ and $p_{12}$; also from the center $e_2$, and with radius, equal to $o\ o_5$, describe the circle $o_4\ o_8\ o_{12}$, cutting the line $a_2\ b_2$ in the points $o_4\ o_{12}$. Through the points $p_4$, $o_4$ draw vertical lines cutting the lines $p\ p_3$ and $o\ o_3$ in the points $p_7$, $o_7$ respectively. Through the points $p_{12}$ $o_{12}$ draw vertical lines, cutting the lines $p\ p_3$ and $o\ o_3$ in the points $p_9$, $o_9$. Join the points $k\ o_7\ p_7\ r_5\ p_9\ o_9$ and $l$ by a curve which will be the vertical projection of the line of intersection of the double curved surface and the cutting plane.

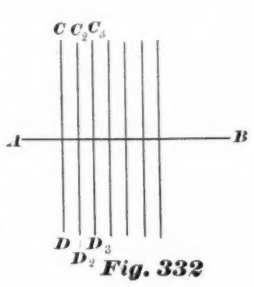


Fig. 332

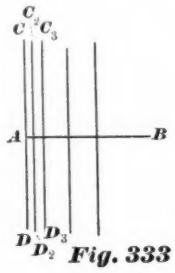


Fig. 333

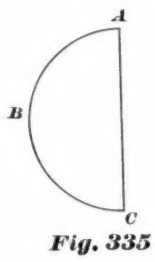


Fig. 335

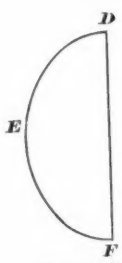


Fig. 336

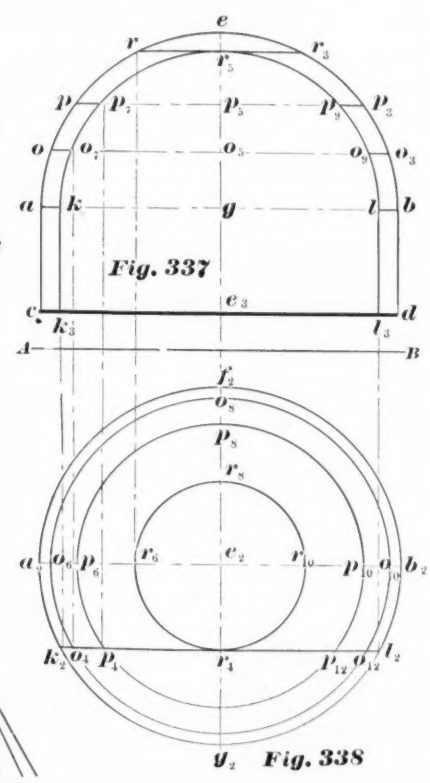


Fig. 337 Fig. 338

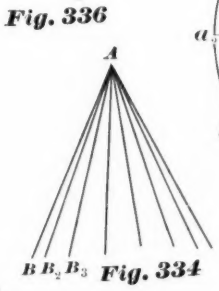


Fig. 334

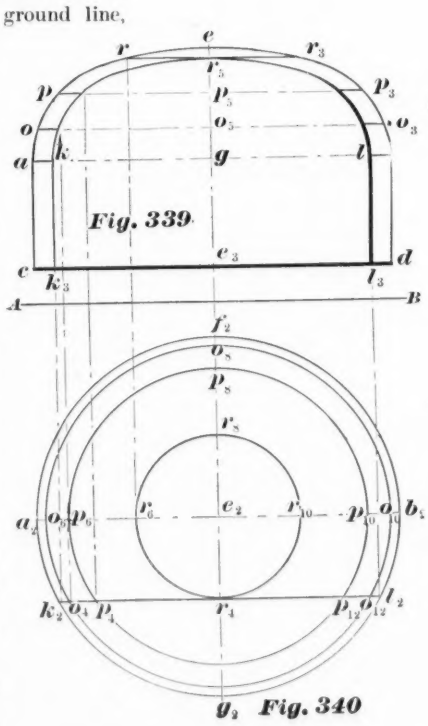


Fig. 339 Fig. 340

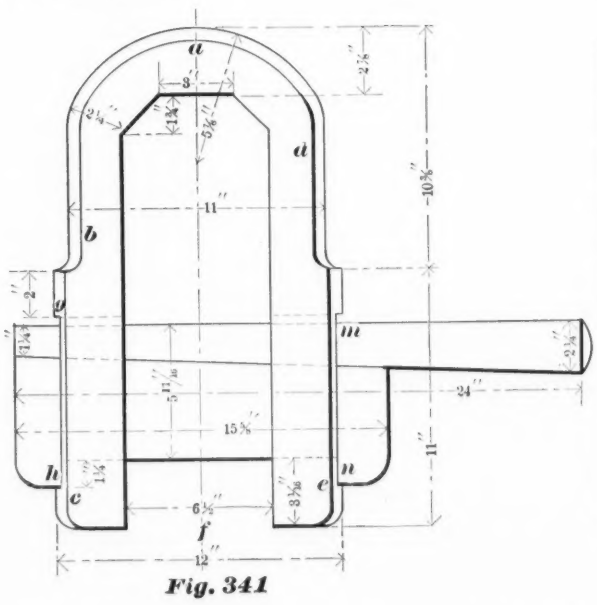


Fig. 341

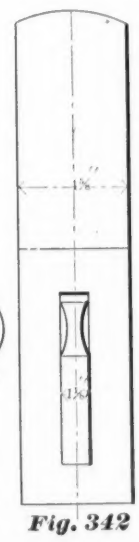


Fig. 342

456. Now let us examine the principles upon which this construction is based. Nothing need to be said as to the manner of finding the lines of intersection $k\ k_3$, $l\ l_3$ of the cylindrical or single curved surface, as the method and principles connected with it have been explained in Probs. 57 and 58. Hence all that is to be considered are the principles connected with the method of finding curved line of intersection.

According to the definition of a surface of revolutions—and such a surface is represented in Figs. 337, 338—we know that planes perpendicular to the axis passed through the lines $r\ r_3$, $p\ p_3$, $o\ o_3$ and *a b* must intersect the surface of the solid in the circumferences of circles. A plane perpendicular to the axis $e\ e_3$ passed through the line $r\ r_3$, will cut the solid in the circumference of a circle whose diameter is equal to the line $r\ r_3$, and since the diameter $r_6\ r_{10}$ of circle $r_4\ r_6\ r_8\ r_{10}$, in Fig. 338, is equal to $r\ r_3$, it follows that the line $r\ r_3$ is the vertical, and $r_4\ r_8\ r_8\ r_{10}$ is the horizontal projection of one and the same circle. The same remarks apply to the line $p\ p_3$ and the circle $p_4\ p_8\ p_{12}$; they also apply to the line $o\ o_3$ and the circle $o_4\ o_8\ o_{12}$, that is to say, the line $p\ p_3$ is the vertical, and the circle $p_4\ p_8\ p_{12}$ is the horizontal projection of one and the same circle whose circumference is the intersection of the double curved surface, and the plane passed through the line $p\ p_3$ perpendicular to the axis $e\ e_3$; also the line $o\ o_3$ and the circumference $o_4\ o_8\ o_{12}$ are the projections of the intersection of the double carved surface, and another plane perpendicular to the axis $e\ e_3$.

When we know the diameter of the circle whose circumference is the intersection of a double curved surface of revolutior and a plane perpendicular to the axis, we can determine, when the ground line is given, the height of this plane above the ground line; or, as in the problem before us, we can determine the height of the plane above the base *c d*. Thus: Let $r_4\ r_6\ r_8\ r_{10}$ be the circumference of a circle in which a plane perpendicular to the axis intersects the curved surface; it is required to find the height of this plane above the base *c d*. Draw the diameter $r_6\ r_{10}$ parallel to the ground line; through one extremity of the diameter, say $r_6$, draw a vertical line, cutting the arc *a p e* in the point *r*, through *r* draw a line parallel to the ground line and cutting the arc *a p b* in the point $r_3$; then the line $r\ r_3$ will be the vertical projection of the diameter, which, in the horizontal projection, is represented by the line $r_6\ r_{10}$; and the distance between the lines $r\ r_3$ and *c d* in Fig. 337 will be the height of the plane above the base *c d*. But now notice that in Fig. 338 the circle $r_4\ r_6\ r_8\ r_{10}$ is drawn tangent to the line $k_2\ l_2$, and the point $r_4$ is the point of tangency. Now, since the point $r_4$ lies in the circumference, $r_4\ r_6\ r_8\ r_{10}$, and since $r\ r_3$ is the vertical projection of the same circumference, the vertical projection, of the point $r_4$ must be the point, $r_5$, in which the vertical line drawn through $r_4$ cuts the line $r\ r$. Again notice that the point $(r_4\ r_5)$ lies in the curved surface, and also in the given cutting plane $k_2\ l_2$, and therefore this point must be a point in the curve of intersection of the curved surface, and the given plane $k_2\ l_2$. Once more, in Fig. 337 the point $r_5$ must be the highest point in the curve $k\ r_5\ l$, because any plane perpendicular to the axis $e\ e_3$ passed through solid above the line $r\ r_3$ will intersect its surface in the circumference of a circle whose diameter is less than $r\ r_3$, and therefore such a circle cannot touch the given plane $k_2\ l_2$, and consequently will not contain any point in the curve of intersection $k\ r_5\ l$.

The points $p_4$ and $p_{12}$ (Fig. 338) in which the given plane $k_2\ l_2$ intersects the circumference $p_4\ p_8\ p_{12}$ are also points in the curve of intersection, or more correctly speaking the points $p_4$ and $p_{12}$ are the horizontal projections of points in the curve of intersection. Now since the circumference $p_4\ p_8\ p_{12}$ is represented in Fig. 337 by the line $p\ p_3$, the vertical projections of the points $p_4\ p_{12}$ must lie in the line $p\ p_3$. Again, since the vertical and horizontal projections of a point must lie in one and the same vertical line, it follows that $p_7$, in which the vertical line drawn through $p_4$ intersects the line $p\ p_3$, must be the vertical projection of the point $p_4$, or of that point represented by $p_4$; and because the point $(p_4\ p_7)$ lies in the curved surface, and also in the given cutting plane $k_2\ l_2$, this point must be another point in the curve of intersection. Similar reasoning applies to the method of finding the other points $o_7$, $p_9$, $o_9$, etc., and consequently the curved line which passes through these points must be the line in which the cutting plane intersects the double curved surface.

457. When we know that the curve *a b e* is a semi-circumference, a construction as shown in Figs. 337 and 338 is not necessary, because in such cases the intersection of the curved surface and the plane will also be a semi-circumference, and is described from the center *g*; that is, the same center from which *a e b* has been described.

When the curve *a e b* is not a semi-circumference, but a curved line, such as shown in Fig. 339, then in order to find the curve of intersection we must adopt the construction as shown. Explanation of the construction shown in Figs. 339, 340 is not necessary, as it is precisely similar to that shown in Figs. 337, 338. And since all the points in both constructions are lettered alike, Figs. 337, 338 may be replaced by Figs. 339, 340, and used in connection with the explanation and reasoning just given with the latter figures.

Here it must be remarked, that when the double curved surface is generated by a semi-circle, as shown in Fig. 337, the distances between the semi-circumferences *a e b* and $k\ r_5\ l$ will be the same throughout; when the generating curve is not a semi-circumference, but is such as shown in Fig. 339, the distances betweenthe curves *a e b* and $k\ r_5\ l$ will vary.

*Directions.*—In space marked Prob. 65 draw the outline of a connecting-rod strap according to the dimensions given in Figs. 341, 342. Then find the line *a b c d e*, which may be considered to be the intersection of a surface of revolution and a plane, by the method given in the last problem. The position of the lines *g h*, *m n* must be found according to the principles given in Probs. 57 and 58. Use a 3-inch scale.

## The Spiral Gear Wheel.

By George B. Grant, Boston.

Two shafts that do not meet may be connected to turn together with a uniform rotary motion by means of a pair of spiral gears, so called because their teeth are generally of a spiral form. The term "screw gear" is sometimes used, but is not in general use.

The accepted theory of the action of the teeth of spiral gears, as first given by Willis, and afterwards adopted by Rankine, MacCord, Rose, and other writers, is erroneous. It does not agree with known facts, and my present purpose is to propose a theory that does harmonize with practice.

### CYLINDRICAL SPIRAL GEARS.

The true theory of this peculiar and not well-known form of gear wheel can be more easily explained if we first take it in its simplest and most general form. The two pitch cylinders, *A* and *B*, Fig. 1, are on shafts that pass each other at an angle, and they touch each other at a point of contact, *O*, that is in the common normal to the two axes. They will be spiral gears if provided with engaging teeth.

### FRICTION WHEELS.

Ordinary spur, bevel, and skew bevel gears may be considered as formed on pitch cylinders, cones, or hyperboloids that roll on each other, and which, in the absence of teeth, would drive each other directly by friction, and the velocity ratio of such gears is the same as that of the corresponding friction wheels.

But the pitch cylinders of spiral gears do not in general roll on each other, would not act as friction wheels, and therefore the same rules will not apply. The position of their teeth has a material effect on their action.

We can, however, consider them as friction wheels acting indirectly on each other, by the aid of an auxiliary flat plate *C*, firmly pressed between them. When this plate is moved in any direction between the cylinders, without slipping on either, it will roll on both, and will rotate both, but each one will be rotated precisely as if the other was not present.

The plate can best be imagined to act on the cylinders by means of fine friction lines or teeth arranged across it at right angles with the direction of its motion, and engaging with similar fine spiral tooth lines on the cylinders. When any tooth line on the plate passes over the surfaces of the cylinders, it will trace a spiral line on each which will roll, not only with the tooth line on the plate, but also with each other.

### LAW OF RELATIVE SPEED.

When the plate is moved at right angles to the axis of either cylinder, it will give the surface of that cylinder a linear speed equal to its own, but when moved obliquely, the speed communicated will be greater as the angle between the tooth line and the axis is greater, until, when that angle is a right angle, the cylinder must move at an infinite speed to allow the plate to move at all.

If the linear speed of the plate is represented by the distance *Oc*, in the direction of its motion, and normals to *Oc* are dropped from the point *c* to points *a* and *b*, on lines *Oa* and *Ob* drawn at right angles to the axes, the distances *Oa* and *Ob* will represent the linear speeds of the surfaces of the cylinders.

These linear speeds are directly proportional to the secants of the angles made by the axes with the tooth line.

### TOOTHED WHEELS.

If the fine friction lines on the imaginary plate are enlarged until they become gear teeth, the friction plate becomes an imaginary corrugated rack without sensible thickness, as shown by Fig. 2, and the spiral tooth lines on the cylinders become spiral gear teeth. But the rules derived from the friction plate will apply without alteration. We then have a pair of spiral gears working together, and the velocity ratio may be determined by the given rules if we know the tooth and axis angles.

### FORMATION OF SPIRAL GEAR TEETH.

Spiral gear teeth may be considered to be derived from rack teeth. If the material of the cylinders is plastic, the spiral teeth will be swept up or molded as the gear and rack are rolled together, and they may be molded in a similar manner by a spiral gear that has been derived from a rack. They may be cut out by a hob, which is the equivalent of the molding gear, planed out in a planer, or cut in a screw cutting lathe, but in each case they can be referred to a rack.

If the cross-section of the tooth of the rack is symmetrical to its pitch line, the curves being odontoids and alike, all spiral gears formed from the rack will work interchangeably with each other.

I do not make the statement that such teeth can be formed in no other way, but no other way has yet been proposed, and it is doubtful if any other is possible.

### BEALE'S SPIRAL GEARS.

If the rack teeth are provided with cutting edges, and the rack is reciprocated as it is rolled on the gear, it will be the plane equivalent of the common hob, and it will form the teeth by planing them out of the solid blank.

This is the process invented by Beale, who first produced a practically perfect spiral gear, and thus called attention to the imperfection of the accepted theory. The details of the process may be found in articles published in the American Machinist for Sept. 12 and Nov. 21, 1885. See also Beale's Treatise on Gearing, published by the Brown & Sharpe Manufacturing Company.

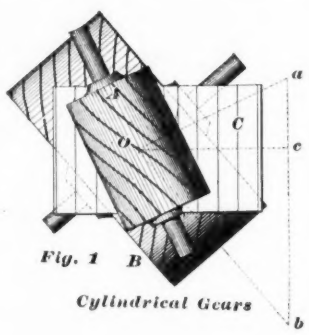


Fig. 1 Cylindrical Gears

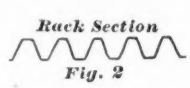


Fig. 2 Rack Section

Fig. 3 Spiral Spur Gears

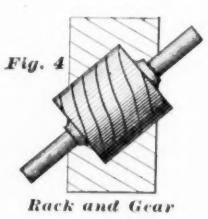


Fig. 4 Rack and Gear

Fig. 5 Worm Gears

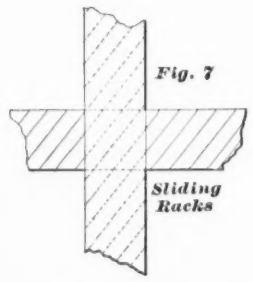


Fig. 7 Sliding Racks

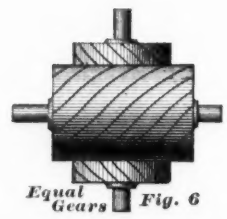


Fig. 6 Equal Gears

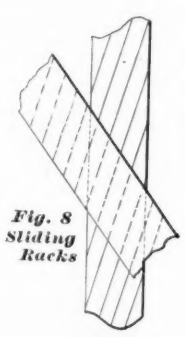


Fig. 8 Sliding Racks

Fig. 9. Spiral and Spur Gear.

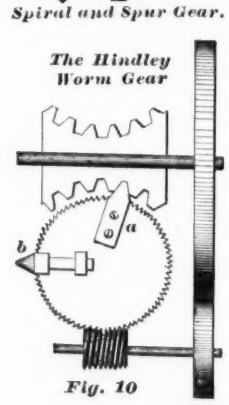


Fig. 10 The Hindley Worm Gear

The tooth outline on the normal section of the rack will form corresponding tooth outlines on the normal sections of the gears, and there will be no perfect tooth contact except on the pair of tangent sections.

### THE NORMAL SECTION THEORY.

This gives us a law of tooth contact that must apply to all spiral teeth that are derived from rack teeth.

*The normal sections of the teeth of spiral gears that work with each other, are conjugate to each other.*

The truth of this law is practically demonstrated by Beale's gears, on which the points of contact cannot only be seen, but their positions can be marked and thus accurately determined.

### THEORETICAL ERROR.

This contact, although practically perfect, is not perfect and continuous from a theoretical point of view, in any case of spiral teeth, formed as described, from rack teeth.

The two normal spiral sections that are tangent to each other at the common normal to the two axes, coincide with each other only on that common line, and the tooth outlines, which are confined to the sections, can engage with each other only when their point of contact is at that line. That is, spiral teeth are mathematically in contact only once during the passage of each tooth, and that contact is at the point of contact of the two pitch cylinders, for, as soon as the normal sections leave the common normal, they diverge laterally, and the tooth outlines must separate.

But this error, although it undoubtedly exists, is not worth serious notice, and its existence need not be recognized. It is microscopic in amount, and I doubt if spiral gears could be constructed accurately enough to show it.

I do not state that perfect contact of spiral teeth is impossible, for it may be possible to produce such teeth not derived from the rack, and to such teeth this argument would not apply.

### KIND OF CONTACT.

When a rack runs with a spiral gear there is contact between them along a line, because each normal section of the rack is in contact with some normal section of the gear.

When two racks run with each other, there is contact over a surface, for then the normal sections coincide.

When two cylindrical spiral gears run together with their axes not parallel, there is point contact only, for in that case there is but one pair of sections in contact.

When the axes are parallel there is line contact, for in that case there is a line of points of contact between the two pitch cylinders and a pair of tangent sections through each point.

When a gear is matched with another that is exactly like it, the two will run together, on inclined axes, for the normal sections are then tangent, and as the tooth outlines are the same they must be conjugate.

### THE AXIAL SECTION THEORY.

The accepted theory of the action of spiral teeth, that of Prof. Willis, was evidently founded on the apparent action of the teeth of the common worm and worm gear, and is substantially as follows:

*The axial section of one gear is conjugate to the corresponding transverse section of the other*

### FAILURE OF THE AXIAL THEORY.

When applied to the common worm and gear, the axial theory is certainly plausible, but, when applied to the spiral gear in general, it entirely fails to agree with known facts.

If this theory is true, there must be two distinct and simultaneous points of contact, for there are two axes, and two axial sections working with two transverse sections.

Beale's gears are conclusive of the fact that there is but one point of contact in the case of two axes at right angles, and that that is not in either axial section.

According to this theory, two gears exactly alike will not run together, and it is by means of Willis' theory that MacCord contradicts Willis' statement that such a pair is possible. Beale practically proves that two equal gears will run together with an accuracy that meets the most carefully made tests.

This theory fails when applied to the extreme case of a pair of common spur gears with parallel axes and straight teeth, which are spiral gears for special tooth and axis angles, and must therefore be subject to any law of a general nature. Here the axial sections coincide, and show a pair of straight lines that come together only once during the passage of each tooth.

According to this theory a worm will run in a gear, when moved without turning, in the direction of its axis. This action is not an example of ordinary tooth contact, but the effect of the successive contact of different spiral sections.

Starting with this theory as a foundation, Willis demonstrates that there is line contact between a worm and a concaved worm gear, and MacCord carries the same theory so far as to define the general nature and mode of action of that line of contact. The line of contact has never been shown on an actual worm gear; any hobbed worm gear will show a point contact in an indistinct and inconclusive manner, and the normal section theory indicates that there is point contact only, along the normal section of the worm.

Applied to the Hindley worm and gear, the axial theory shows a line contact along the

axial section of the worm, and no contact at all elsewhere. The normal section theory indicates point contact only.

The axial theory, applied to the roller worm gear, shows that a line contact, or any axial contact at all, is impossible, while the normal section theory shows a perfect line contact.

DIRECTION OF THE TOOTH SPIRALS.

When the axes are at right angles, the directions of the tooth spirals must be the same, both right or both left, and the direction of rotation of one of the gears will change with the direction of the spirals.

When the axes are parallel, the spirals must be opposite in direction, one right and the other left hand, and the direction has no influence on the rotation of the gears.

When the axes are neither normal nor parallel, the direction of the tooth spirals may be alike or opposite.

THE CONCAVED WORM GEAR.

When the spiral gear is provided with cutting edges, it will act as a hob, and will cut teeth in a gear blank with which it is in contact, producing a gear having a concave or cupped face.

In the absence of an actual worm and concaved gear, under conditions that will clearly show the contact, I am not able to make any positive statement concerning it, but the normal section theory plainly indicates that it is point contact along the normal section of the worm. Willis' proof of a line of contact fails unless the truth of his axial theory is admitted.

This form of gear has more teeth in contact at a time than the cylindrical form, and the surfaces near the point of contact are very nearly in contact. Under pressure there is practically a surface contact.

THE HINDLEY WORM GEAR.

When the worm hob is formed as by the tool *a* of Fig. 10, it will cut a concaved worm gear with which all its teeth, within ordinary limits, will engage. As in the case of the common worm gear, I cannot demonstrate the kind of contact in a practical manner, but I can see no reason for changing the theory, and should expect such gears to show point contact only.

I expect to soon be able to show the contact, on both this and the common form of worm gear, by models made for that express purpose.

It is quite evident, however, that the Hindley worm and gear will not bear, as commonly supposed, by line contact along the mid or axial section. The hob made by the tool *a* will not cut a gear that will fit and fill its axial section. The Willis' theory that proves line contact on the common worm gear, also proves the Hindley gear to have no contact at all away from the mid section.

SPECIAL FORM OF THE HINDLEY WORM GEAR.

We can produce a worm and gear having line contact by making the hob with a revolving milling tool, *b*, Fig. 10, in place of the lathe tool *a*. A gear produced by such a hob would have teeth situated in the axial section of the worm, but each one would fit on a normal section.

ROLLER WORM GEARS.

A worm formed by the tool *b* of Fig. 10 will run with a worm gear having teeth or pins of the form of and in the position of the milling tool. Friction may be reduced by using rollers instead of the fixed pins.

MacCord says that "these rollers cannot be made cylindrical," and also that such a tooth "has at no instant more than a single driving point," and he illustrates a form of roller, which he states can have a point contact on the meridian section of the worm. The roller, he admits, is quite as impossible as the one he rules out, and for the same reason, according to the axial theory.

The normal section theory shows that either roller will work, by line contact, along normal sections of the worm.

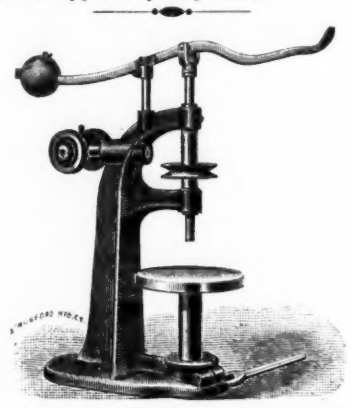
EFFECT OF FRICTION.

Theoretically, either one of a pair of spiral gears will drive the other, but friction will often modify this feature and require that the one having the greatest tooth angle shall be used as the driver. This is clearly seen in the worm gear of Fig. 5, or in the racks of Fig. 8.

UNIVERSAL APPLICATION OF THE THEORY.

The normal section theory appears to be quite universal in its application, and to apply not only to the spiral gear, but to the spur, bevel, and skew bevel gear. All gear teeth appear to bear on sections that are normal to their direction.

The normal surface of the skew bevel gear appears to be a spherical helix, which becomes a plain helix for the spiral gear, a spherical surface for the bevel gear, and a plane for the spur gear. Conjugate odontoids in these normal surfaces can work together when the surfaces coincide, as in bevel and spur gears; but when they are helical and can only be tangent at points or on lines, as on spiral gears and skew bevel gears, continuous tooth contact is apparently impossible.



**New Bench Drill.**

The illustration shows a small drill press made by the Pratt & Whitney Co., of Hartford, Conn., and by them designated the No. 1 Bench Drill. It has been designed especially for small, light work, such as is done by the makers of electrical appliances, and is designed to run at a high speed, gears being dispensed with, and the driving effected by a half-inch round belt. It is intended to drill holes up to $\frac{5}{16}$" diameter.

The spindle is of steel, $\frac{5}{8}$" diameter, and has a vertical movement of $2\frac{1}{2}$" by means of the lever at the top, which carries an adjustable weight for counterbalancing the spindle.

The table is 7" diameter, and can be elevated $4\frac{1}{4}$", and clamped at any desired height within that limit, its greatest distance from the end of the spindle being $7\frac{3}{4}$" The distance from the center of table to face of column is $4\frac{1}{2}$".

A countershaft is furnished, having 4" × 2" tight and loose pulleys, which, for a $\frac{1}{8}$" drill, should run at 280 turns per minute. The weight of the machine is 80 pounds.

## Foundry Cupolas.

BY ROBERT E. MASTERS.

Fig. 1 is a sectional view of Greiner & Erpf's cupola. *A* is the bottom, and *B* the bottom line of the charging door. There is an air chamber *C* around the cupola for the lower tuyeres; above this there is a supplementary air chamber or pipe *D* connecting with the lower air chamber at *E*. There are valves *F* in these pipe connections to shut off the blast from the upper series of tuyeres, which are placed spirally around the cupola from *G* to *H* and *I*; each upper tuyere has a separate branch pipe *J J*. It will be noticed that the upper series of tuyeres are placed higher than any other cupola now in use.

This cupola has, previous to this, been described, in substance, as follows: "Carbonic oxide in ordinary cupolas is formed about the line *K*, while in cupolas of two rows of tuyeres it takes place at *L*. Messrs. Greiner & Erpf, in their endeavors to solve the problem of the utilization of the inevitable carbonic oxide, after careful study of the phenomena attending combustion in cupolas, perceived that to effect the required results the combustion of the carbonic oxide must be commenced at a point so far above the fusion zone that the descending coke has not attained the temperature necessary for ignition, while the ascending combustible gas is still hot enough to ignite on contact with air. Furthermore, the burning of the gas must not take place in one horizontal plane, but must be distributed through some depth of the charge; otherwise the concentration of the heat would cause ignition of the coke and consequent loss, by introducing the supplementary blast where the fuel has not quite attained the temperature necessary for ignition; the carbonic oxide is thus burnt to carbonic acid and the descending coke and metal receive the full benefit of the combustion temperature.

"Cupolas with two rows of tuyeres are undoubtedly much more economical than some of the older types, but experience has proved this to be due to improvements in shape and proportion of parts, rather than to the utilization of carbonic oxide. Proof of the general non-efficiency of the double set of tuyeres is afforded by the fact that many cupolas originally constructed with two sets have their performance improved by the removal of the upper row."

This may seem a startling announcement to some, but it is my experience exactly. There are a number of points concerning the construction and operation of cupolas that are considered very modern by many, but which, if traced up, will be found to be rather ancient. I tested the double row of tuyeres when they were all the rage, but failed to discover the wonderful results claimed for them, and the experiments were not confined to one cupola alone.

In heats of from 25,000 to 50,000 pounds of iron, cupolas have been tried under the same conditions of blast pressure, fuel, etc., one heat with the upper tuyeres open, the next with them closed, or a trial of a week given to each plan without discovering the difference in the melting in favor of the upper row, but with the upper row of tuyeres open the brick between the two rows, and just above the upper row, burned and cut out a great deal faster than we thought was profitable, so the upper row was shut up entirely; yet the cupola gave better satisfaction than the old types. If there is any advantage in point of fuel with both rows in operation it is counterbalenced by cost of fire brick and labor of lining. There are, as stated

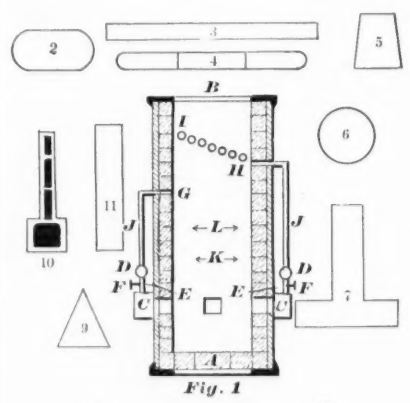



*Fig. 1*

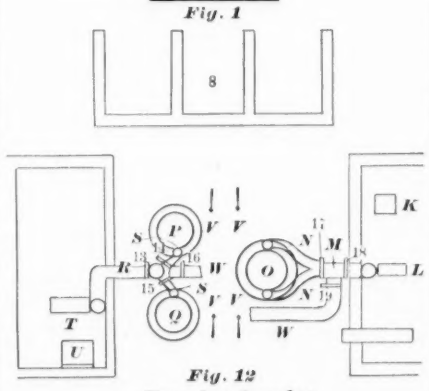



*Fig. 12*
*Foundry Cupolas*

above, a number of cupolas with double rows of tuyeres in operation to-day with the upper row entirely stopped up. I have in mind an account published by a foundry foreman of the grand results he obtained from this type of cupola, when to my personal knowledge the upper tuyeres in that cupola have been kept closed nearly ever since it was erected.

From Nos. 2 to 11 are shown, together with those that have been illustrated in previous articles, about all the shapes and styles of tuyeres that are in use. Fig. 10 is the Lawrence reducing tuyere; Fig. 9 is a tuyere introduced by Edward Kirk, of chemical compound flux fame; Fig. 8 is not very much used, and no doubt will be thought an unusual shape; but, in fact, there is not so much in the shape of tuyeres after all; the chief points are to get them properly placed, and in proportion and number to the size of the cupola.

A very prominent foundryman in St. Louis, who has melted in the neighborhood of 200 tons of iron a day, called my attention to a cupola in which he was melting over 100 tons of iron daily. The tuyeres were $2\frac{1}{2}$" wide and 20" long, on the plan of No. 11. When they wanted a deep bottom they bricked up 8 inches of the lower part of the tuyere; when they did not require a deep bottom the bricks were taken out of the lower part and placed in the upper part of the tuyeres, so in any event, whether high or low, the tuyeres were $2\frac{1}{2}$" × 12". This gentleman said in the various cupolas he had used, as far as melting was concerned, he found no real advantage from any particular shape of tuyere, if they were properly arranged and operated, and the most satisfactory results he had obtained, as far as economy goes, on all points, was in melting seven to eight pounds of iron to one of fuel, even in large heats.

There is a new cupola now offered to the trade, called "The Water-Jacketed Cupola." It is claimed to be especially adapted for both iron and brass founders, and for the treatment of phosphor bronze, and by the addition of a small per cent. of aluminum, steel castings can be produced. In operating this cupola the expenses for repairs are considered a very small factor. It differs from the foundry cupolas now in use, from the fact that the bottom once made will answer for months without having to "drop it."

Often what would be a good heat receives a serious check, and is occasionally lost from a break in the belts, or fan, or engine, which brings things to a dead stand. This occurs now and then, even if all the appliances are carefully inspected (as they should be) before each heat every day, and the break always happens at the most unfortunate time.

Another bad feature to be found in some foundries is, the sheet-iron blast pipe is buried in the ground between the fan and cupolas. Right in the middle of a busy season something happens to the pipe, and even if the exact place can be located it stops the foundry two or three days to dig out and repair the pipe, if there is any left to repair. I remember one case where the pipe had rusted entirely away, and without knowing it we were conveying the wind through a hole or tunnel in the ground, but finally learned the condition of things when the blast cut through, and we had to shut down for several days to make and put in new pipe. There are only a few instances where there is any other excuse for burying blast pipes besides incompetent engineering. Even under the best conditions they are not as safe or handy as when placed overhead, where an application of paint now and then will keep them from rusting, and they are out of the way, and not getting banged all out of shape when dropping the bottom or getting the cinder out from under the cupola.

Fig. 12 shows an arrangement of blast pipes connecting the cupolas in the Marshall (Texas) Car Wheel and Foundry Co.'s works that can be advantageously employed in many foundries using two or more cupolas run by separate engines. *K* is a 30 horse-power engine; *L* No. 9 Sturtevant fan; *M* 20" main blast pipe; *N N* 12" branch pipes; *O* 48" Colliau cupola; *P* is a 38" cupola having six tuyeres $2\frac{1}{2}$" × 8", shaped like No. 11. This cupola is 15" inches from bottom plate to bottom of tuyeres, and 11' 4" from bottom plate to bottom of charging door. Cupola *Q* is 38" diameter, and has the same number and same style of tuyeres as cupola *P*, $2\frac{1}{2}$" × 12". The bottom of these tuyeres is 18" from the bottom plate, and the cupola is 10' 11" to charging door. *R* is a 16" main blast pipe, and the branch pipes *S S* are 8" × 18" where they enter the air chamber. *T* is a No. 7 Sturtevant fan, and *U* a 12" × 24" upright engine.

The cupolas are located at opposite ends of the foundry, 265 feet apart, and are outside of the foundry walls, which are on a line with *V V*. The blast pipe *W W*, which is shown broken off, is 16″ diameter. It rests on the trusses of the building, and the bend it makes in the distance between the cupolas is scarcely noticeable. With this arrangement, if anything occurs at one end to stop the blast, by moving certain of the slide valves, which are indicated by Nos. 13 to 19, the blast can be furnished in short order from the other end. For instance, when blowing in cupola *Q* from fan *T*, valves 14 and 16 are closed, and 13 and 15 are open. Now, if a break should occur to belts, fan or engine *T U*, we close slides 13 and 17, and open 16, 18 and 19. No. 15 being already open, we start up engine *K* and blow from fan *L*.

I call particular attention to the arrangement and sizes of these blast pipes and cupolas, because it will have an important bearing on what I may say hereafter.

## Large and Enlarged Photographs and Blue Prints.

By R. H. Thurston, Ithaca, N. Y.

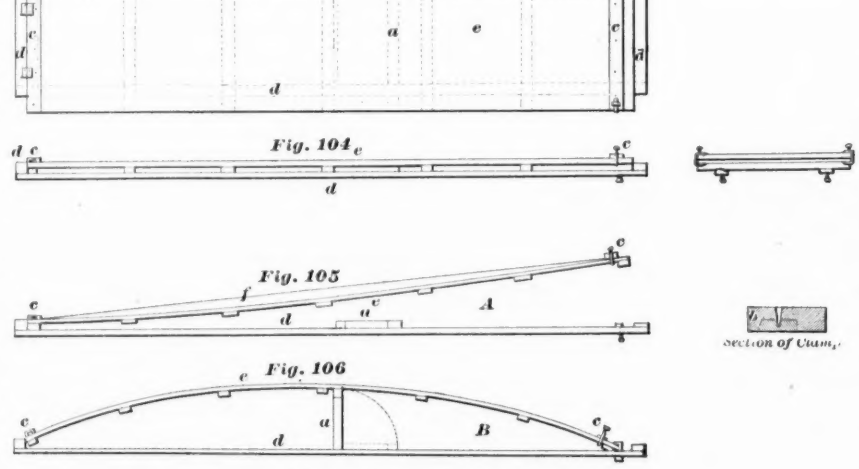
A PAPER PRESENTED AT THE NASHVILLE MEETING OF THE MECHANICAL ENGINEERS.

The writer has, on an earlier occasion, presented to the society, with the kind permission of Prof. E. C. Cleaves, samples of blue prints of extraordinary size, as made by a method, and with apparatus, original, it is believed, with that gentleman. That exhibited at the Washington meeting of this society, and a similar one exhibited at the Kaaterskill meeting of the Civil Engineers, were 8 feet long and 3½ feet in width. It will be remembered that they were made on a revolving cylinder, contact being secured simply by drawing the tracing tight over the sensitive paper and the underlying felt by means of suitably arranged clamps and springs. No glass was needed, and the expense and risk, and something of the trouble, of the common method of operation was thus avoided.*

The writer has since had some still larger prints prepared by a still simpler apparatus and method, original with himself, and by which an almost unlimited area of surface may be printed. The blue print accompanying this paper is a sample of what may be easily done in any drawing-room in which light can be obtained for such extent of print. It is a blue print from a tracing of one of Captain Zalinski's latest forms of pneumatic dynamite gun shells, as designed by him for the fifteen-inch gun now under construction. The print is 14 feet long and 2½ feet wide. It is a good sample of the fine work in printing and toning which is done by Professor Cleaves for the Sibley College of Cornell University. The formulas for the re-agents are derived by a systematic course of experimental investigation directed to that end some time since.

The printing apparatus used for this later work consists of nothing but a single thin board, of the length and breadth of the proposed print, with some margin for the stretching clamps. This board is covered with good felt of carefully selected quality, securely and smoothly fastened to the board by any convenient means. A line of tacks around the edges does as well, perhaps, as anything. The sensitive paper is then stretched over the felt, and the tracing drawn over that, and both are smoothly stretched by clamps or other convenient device. It is of course evident that it would not be practicable by this operation simply to obtain that complete contact and pressure throughout the surface in contact that is required for good work; but this desideratum is easily secured by the simplest expedient imaginable: The board is merely sprung to a flat arc in the direction either of its length or of its breadth, ordinarily in the longer line. This brings everything "taut," and the printing is done precisely as under glass, with the further decided advantage that no light is lost through the intervention of the glass, which, however excellent in quality, will inevitably absorb a very measurable amount.

The accompanying sketch represents the apparatus designed by Professor Cleaves for the purpose of carrying into effect the suggestion of the writer in the making of the very large prints of which that presented herewith is a sample. Figs. 103 and 104 are a plan and side elevation of the board and its mounting. It will be seen that the upper, or printing board, is supported upon a lower and somewhat narrower and longer one, which, in turn, should be carried on trestles or other convenient arrangement. The printing board is stiffened laterally by strips or battens, but is free to spring longitudinally to any desired extent. The supporting board is stiffened longitudinally. At each end of the latter is a batten *d d*, set transversely, which answers as a chock, as seen later. Clamps *c c* are placed at either end of the printing board, by means of which to secure the felt, paper, and tracing. One or both of these clamps may be made adjustable for varying lengths of print. Figs. 105 and 106 show the method of operation. The board is first raised at one end and thus slightly sprung. The felt and paper, and the tracing which forms the negative, are stretched smoothly between the clamps and well secured. The board is next laid down on the supporting base, the two ends made fast, the one to the batten at the left, the other to another arranged at the proper distance from the right hand extremity, the




Making Large Blue Prints.

printing board springing into a curve of which the bridge *a*, hinged at the middle as in *A*, and thrown up as seen in the sketch *B*, gives the versed sine. By springing to any desirable extent as in *A*, and then reversing the curve as in *B*, any required degree of tension and stretch can be given the tracing, and thus any necessary amount of pressure and perfection of contact with the sensitive paper may be obtained. The two sections at the right exhibit the end view of the pair of boards and a section of the clamp used.

It is obvious that this scheme will suffice to print any area of blue-print that paper can be obtained to cover—a half-mile square if necessary. The amount of springing required is very small, and never enough to affect perceptibly the uniformity of the printing and tone of the print. If it should ever seem too great, it is easy to correct the defect by first springing the board in the reverse direction; then, after drawing the covering felt and papers tight, bending it in the first proposed direction, past the straight line, and as far as may be found desirable to secure good contact. We have found this method to work quite as well as the cylinder; which we still use, however, for what we now call *small* sizes. Perhaps this may be as well or better than the new method, up to eight or ten feet length, and for narrow prints; while the new arrangement may do best whenever extraordinary sizes—as gauged by our new standard—are called for.

We are doing another quite different kind of work in photography, which proves to have great value for certain purposes. Professor S. B. Newberry, in charge of organic and applied chemistry, has, for some time past, been experimenting with various methods of enlarging photographs, and has succeeded in producing such enlargements very successfully in sizes which are remarkably well adapted to the purposes of the instructor in making wall-charts, maps, drawings of architectural subjects, and of machinery. I have now received from him excellent reproductions, on a scale of about 2½ by 3½ feet, and 3 by 4 feet, of full-page plates from the engineering journals; portraits from cabinet pictures of great engineers and inventors, and other interesting subjects, such as could not have been economically obtained by either redrawing, or any of the older processes of reproduction, and at a cost so small as to make them very freely available. They are clear, distinct in line and in all details, and are quite large enough and bright enough to serve admirably for wall-charts. The effect is particularly excellent in making views of architectural subjects and of machinery which is at all complicated, such, for example, as full drawings of marine steam engines.

## Design, Construction, Repairs and Management of Marine Steam Engines and Boilers.

By W. H. Hoffman.

SIXTH PAPER.

We will now consider the crank-shaft as three independent sections bolted together, thus forming a continuous built-up steel shaft. I think it is a mistake, when designing a crank-shaft with a view of using some type of radial valve gear, to leave no room on the shaft for eccentrics. While many of us favor any of the good and well-tried radial valve motions, it must not be forgotten that there are others who do not agree with us concerning this important part of the engine, and therefore designers must make due allowances for the opinions of the believers in the old link motion, as the latter type is still doing good service. Some radial gears have one eccentric, which works in combination with the radial bars, so there must be room on each section of the shaft for one eccentric at least, and a little additional length on the shaft gives us room for any kind of valve gear. If the link motion is used, the forward end of the shaft must project far enough from the end of the forward box to allow for three eccentrics, if an independent cut-off valve is used, and a similar space is required on each section of shaft.

There are some designs in which *all* of the eccentrics are placed abaft the after crank-shaft bearing, each set being connected to an independent rock shaft that transmits the proper motions to the three or six valve stems, as the case may be. These eccentrics and straps should be interchangeable, also the rod arms and pins, so that, should a main valve strap or rod give out, the cut-off valve details could be substituted, after first blocking the cut-off valve clear of everything.

Considering the wear and tear, friction, etc., I think the best plan is to adopt some durable radial valve gear for all marine engines driving screw propellers, and use the link motion only when prejudice against the radial motion prevents its application.

The side plates of the cranks have been made in various forms, and in the modern engines we see a variety of cross sections. When close counterbalancing is done at the crank plates, the counterweight should be forged on in the small sizes, and bolted, keyed or shrunk on in the medium and large sizes. The diameter of the body of our shaft must be 15¼″, and the thickness of the crank arms must be enough to insure a rigid and steady grip on the shaft. The thickness of each crank side or plate should be $\frac{8}{10}$ the diameter of the crank-shaft journal, so our crank arms or sides will be 10¼″ thick.

This rule leaves a large margin of strength, as the bending and torsional strains occurring need but a little over two-thirds of this thickness to insure safety, but the latter thickness would not offer a good holding fit for the shaft. Our crank is 27″ centers, and our bending strain must be calculated from this dimension.

The diameter of the shaft and crank-pin ends of the arms must be 2⅛ times the diameter of the shaft and pin bodies. So this will make the hubs 33½″ in diameter, and this gives a thickness of 9½″ on each side of the shaft body. From this thickness we must deduct the depth of the keyways (⅛″), which will leave us a solid thickness of 8¼″, and give us a total sectional area of 84½″. This section, with an allowance of 7,500 lbs. safe working stress per inch, gives us a safe resistance of 633,750 lbs., while the actual stress at this point will be but 200,000 lbs. total, and thus providing for extra shock. Of course the coupling flanges are forged solidly on the shaft, and the thickness of these should be one-third (⅓) the diameter of the shaft journal, in order to give us a section, after drilling for the coupling bolts, strong enough to resist the bending and torsional strains as readily as the journal. We shall therefore make our coupling flanges 4¼″ thick, and round the corner from the back of the flange to the shaft, with curve having a 2¼″ radius.

The diameter of coupling flange should be $1\frac{85}{100}$ times the diameter of the shaft journal, and this makes our flange 23½″ in diameter, and it should certainly be no less. Numerous coupling bolts give better results than a small number, for the reason that they distribute the bending strain on the flange more uniformly. The bolts in a coupling of the size of ours must be pitched about 5″ centers, or, say, twelve bolts, placed nearly equidistant between the outside of the flange and shaft, and counterboring for heads and nuts at the corner if necessary. The cross key, which must have a width equal to $\frac{4}{10}$ the diameter of the shaft journal, or 5″, will be strong enough to resist three-fourths of the torsional load, so that only one-fourth of the twisting action can reach the bolts under any circumstances, and practically the cross key will easily carry the steady working load, and it is only in the case of undue shocks from heavy weather, and consequent racing, that the bolts will be called on to resist torsion. The tensile stress on one-half of the bolts caused by the bending strain is 140,000 lbs., supposing the distance from the center of the crank-pin to the face of the coupling to be 40″. Thus we shall have a stress of 140,000 lbs. on six steel bolts, or, say, 24,000 lbs. on each bolt. Coupling bolts for marine work should have a factor of safety of 8, and if we use mild steel of about 60,000 lbs. per square inch ultimate strength, our safe working load per square inch will be 7,500 lbs. This calls for a cross section of 3½ square inches on each bolt at the *bottom* of the thread, or 2⅛″ in diameter at this point. In order to have the body of the bolt above the thread, the extreme diameter must be 2½″.

These bolts should be ground true on centers after being turned, the finished size being suited to a standard reamer. There should be a finished washer ½″ thick under each nut, and the nuts should be case-hardened.

There must be two keys of steel to each crank end of the shaft, and also to each end of crank-pins, pitched, say, at ½. There should be a facing projection ¼″ deep on each

* Trans. A. S. M. E., Vol. VIII., p. 722.

crank arm, and next to the main boxes, to allow for the usual end wear in a fore-and-aft direction, the diameter of these projections being the same as the end of the main boxes.

Before putting the crank arms on to the several shafts there should be center lines drawn with a marking tool across the outside faces of the cranks, which will be used in setting the shaft sections together, and also in measuring the position of the crank centers in adjusting the valve motion, etc. These, and other lines marked on the main guides giving the position of the crosshead at full, half, one-third and six-tenths of the stroke, will be found very convenient in setting valves. After the three sections are ready to bolt together, the faces of the flange couplings should be cleaned thoroughly, and then tried with a square and surface table to detect any errors in the squaring up process on the turning lathe. The accuracy being determined, the sections should be placed on an arbor of the size of the hole in the center of the shaft ($4\frac{1}{4}$"), the coupling bolts drawn up snug, and the final finishing cut taken off. The journals should then be ground on centers, and after the latter operation is completed, one section should be removed and the *spare* section or sections substituted and finished in the same manner.

The crank-pins will be ground in the journals, of course. This system of fitting up a sectional built-up crank-shaft will produce a practically perfect shaft. It will be true in all its journals, and the crank arms will be square with the center of motion. Any number of duplicate pieces can be made to run with absolute accuracy. The shop work is simple, and requires but little in the way of extra fixtures.

About three years ago a solidly forged iron crank-shaft of a new two-crank compound engine, in a new vessel sailing from the port of New York, gave no end of trouble from heating and cutting. After running some months it was removed, and when it was hung on centers it swung $\frac{3}{16}$" from a true line. It was then re-turned on a lathe proportioned to the weight of the shaft, the boxes were re-bored after being planed together, and there was no further trouble. The speed of the engine could be held steadily at 90 revolutions, while previous to the change the speed was from 60 to 70 revolutions, with the shower-bath on nearly all the time, and stoppages frequent. The above example illustrates but one case of inaccurate tool work in fitting up the most important detail of transmission in an engine. This vessel lost 136 hours out of one month's work, and it cost more to learn the cause of the heating and cutting, and correct the same, than two new steel built-up sectional crank-shafts would cost.

It is the practice of the best marine engine builders to turn crank-shafts in their heaviest lathes, for even if the machine does appear at first sight to be out of all proportion with the work, it is sure to give us a straight shaft, if the lathe is true in its centers. After the shaft is completed in the shop it should be placed in a special set of centers, bolted to a heavy surface plate, and tried with a surface gauge the whole length of each journal. We shall then know just how it will hang in the bed housings and boxes, and there will be no need of correcting machine shop errors on board ship.

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By the giving way of a bridge on the Burlington road, near Alma, Neb., April 27, its fast train, the "cannon ball," was wrecked, resulting in injuries and loss of life. We think there is little or no excuse for such occurrences, but we suppose the usual explanation will be put forth—that is, the company will find that it was not caused by any weakness of the bridge at all, but that the train ran off the track and knocked the bridge down.

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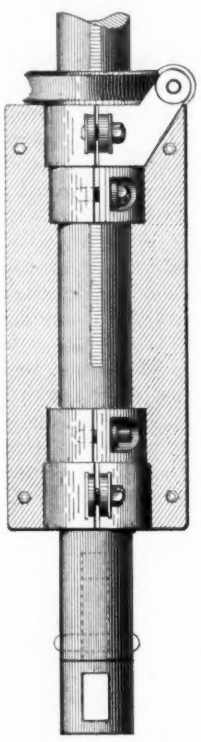
Byron E. Parks, whose address we gave in connection with a link grinding machine in our issue of April 28 as Big Rapids, Mich., writes us to say that Big Rapids was only a temporary address; that his permanent address is 392 Scribner street, Grand Rapids, Mich.

## LETTERS FROM PRACTICAL MEN.

### Another Slotting Machine Bar.

*Editor American Machinist:*

Allow me to contribute my mite to the slotter bar question, by a sketch and description of a bar that I have made, and one of which has been in use for some years.



The bar proper is made round, and of uniform size, with a pivoted head to receive any shape tool desired, the tool being held either by a wedge or set screw. The bar is held by two brackets, as shown in my sketch, one of which has lugs to support a worm which meshes into a worm gear on the bar. A feather in the worm gear works in the key-seat whichis cut in the bar.

By putting a ratchet on the worm shaft, the bar can be turned to any angle, or it can be used for feeding around small curves, by setting the tool out to the desired radius.

The brackets can be made separate, with holes to go over the studs in the case of a small machine, the sketch showing the arrangement for a very large machine.

GUS LUCK.

Milwaukee, Wis.

### Green Sand Cores for Curved Pipes.

*Editor American Machinist:*

Having been much benefited by the constant perusal of your paper for the past four or five years, I have often wished that I might return a favor in kind to some of the correspondents. Perhaps I can do so now. I see in your issue of April 21st that Frank Kavanaugh asks how to make green sand cores for curved pipe. I enclose a hastily made sketch of a plan not new, but found to work very well.

Fig. 1 is a side elevation showing the core in place, and Fig. 2 is the nowel with core arbor placed in position. The flask, preferably of iron, has a pair of brackets nicely fitted to the core prints, which project through the sides on the top and bottom sides.

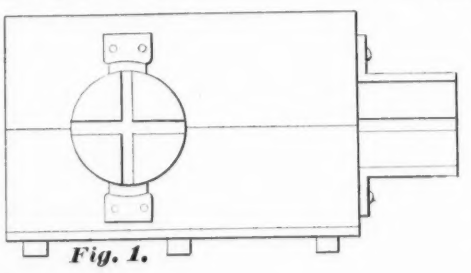


*Fig. 1.*

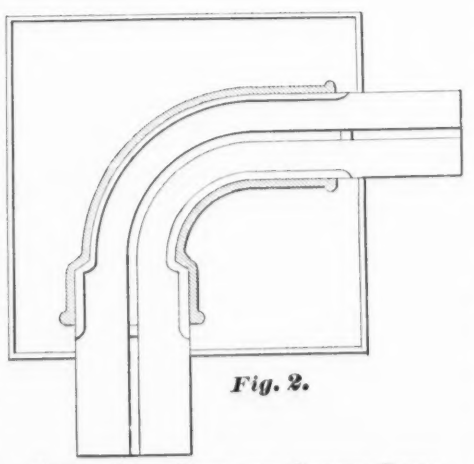


*Fig. 2.*

GREEN SAND CORES FOR CURVED PIPES.

The core arbor is made + shape and fitted into the core box so as to fill the prints nearly back to the casting; then it is cut back so as to leave a coating of sand. The core arbor can be made in two or more pieces, as may be needed to come out of casting easily, and dovetailed together. When the core is in place and the flask closed, the brackets bearing on the wings of the arbor will hold it firmly in place. This worked finely for the making of $\frac{1}{4}$ bends, traps, etc., we very seldom losing a piece from any fault of the core. Of 4" $\frac{1}{4}$ bends one of our men used to make forty in one day, making his own cores.

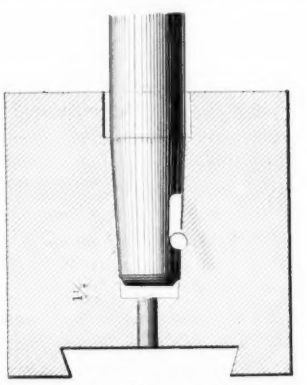
H. C. WILLIAMS.

### Securing Hammer Heads.

*Editor American Machinist:*

In the answer to Question 81 (in your issue of Feb. 18) you give an illustration, Fig. 3, of one way of securing hammer heads to piston-rods. Some firms make a slight departure from this method, and I think must necessarily secure better results. Their plan is illustrated in the accompanying sketch. A small space left below the bottom of the rod allows taper portion ($\frac{3}{4}$ inch to 1 foot, length of taper equal to twice the diameter of rod) to drive into ram good and solid. The pin is for the purpose of raising the ram during the first stroke or two of hammer. When the piston-rod is first placed into the ram, the pin is made to rest against the lower end of the notch planed in the rod, giving the pin about one inch play above it, for driving the rod. There is also a space in the ram around the straight part of the rod, as it is thought to be a difficult matter to obtain a perfect fit around the straight, and also the tapered part of the rod. I have known hammer heads fitted up in this style (taper portion a good ground fit) where it was necessary to bore the rod out of the ram after it had snapped off. This tight fit was caused simply by driving the rod into ram, working the hammer under ordinary circumstances; no shrinking of ram to rod or anything of that kind being necessary. In one case, where the piston had been fitted into ram, as here shown, the ram was heated to expand, which generally answers the purpose of loosening the rod, but was "no go." I have heard some suggest that there was danger of splitting the ram with this arrangement, but I never knew this to be the case, and have seen many hammers built. However, care should be taken to set the anvil $1\frac{1}{2}$ or 2 inches higher than the working level, to allow for the natural settling of the foundation, and also for the probable $\frac{1}{2}$ inch drive of piston into rod.

A. L.



SECURING HAMMER HEADS.

### Melting in a Small Cupola.

*Editor American Machinist:*

I have been very much interested in the articles on foundry practice appearing for several years in the AMERICAN MACHINIST. I want to learn still more, in the foundry line especially, and so look every week eagerly for something that will hit us "little fellows."

I will give you a description of my first melt with "Walston" coke, and the last one to date also, and would like to have those of greater experience tell me if I am doing as well as I can do with what I have to do with; or, if better can be done, let me know how, and by so doing they will help lots of us who can only get what information we can through books and papers. I use altogether old scrap, three-quarters old stove plate—cannot afford to use pig on account of freight rates.

MELT OF APRIL 4TH, 1888.

| | | | |
|---|---|---|---|
| Fire started | | | 2.30 |
| Put on wind (one-half) | | | 3.20 |
| " " (full) | | | 3.23 |
| Dropped bottom | | | 3.45 |
| Bed coke | 150 lbs. | Iron, 1st, | 500 lbs. |
| 1st charge, coke | 50 lbs. | " 2d, | 300 lbs. |
| 2d charge, coke. | 50 lbs. | " 3d, | 400 lbs. |
| | 250 lbs. | | 1,200 lbs |

Fifty pounds of old coke was taken from this dump and used in melt of next day. Iron came very hot and good. The iron was a mixture of old stove plate, very rusty and dirty, sprues, mowing machinery and small car wheels, about equal parts.

Cupola 30" shell (boiler); height from plate to charging door, 6 feet; inside diameter at charging door, 21"; burned out to about 26" at melting point (about 10 above tuyeres). The wind pressure is equal to five inches of water. The cupola came near cutting through, and I had to put in one row of fire brick at the melting point, which made the cupola a little less than 21 inches at that point at the time the next melt described was made.

I use two tuyeres oval, $2\frac{1}{2}$ high, 4" wide. The cupola burns out oval by cutting out over the tuyeres. The sand bed is six inches from bottom side of tuyere holes in the middle, and four inches at the back.

MELT OF APRIL 21, 1888.

| | | | |
|---|---|---|---|
| Fire started | | | 2.45 |
| Front put in and began to charge | | | 3.15 |
| Wind on | | | 3.21 |
| Iron started | | | 3.26 |
| First ladle iron | | | 3.28 |
| Bottom dropped | | | 3.55 |
| Bed coke | 175 lbs. | Iron, 1st, | 600 lbs. |
| 1st charge, coke | 50 lbs. | " 2d, | 500 lbs. |
| 2d charge, coke. | 30 lbs. | " 3d, | 500 lbs. |
| | 255 lbs. | | 1,600 lbs. |

Forty-five pounds of coke was taken from this dump, about as good as new. All the iron was melted, came at fair rate at first, and iron was good all the way through; the melt came very fast at the last—all that four hands could do to take care of it, and pour my light work flasks, from 6 to 25 pounds each.

The iron was about one-half old stove plate, very rusty and dirty. The balance was old sprues, and old mowing machinery, wheels, etc.

The sand bed was 7 inches from tuyeres in the middle, and 5 inches on back.

I find coke to make more slag than coal, but in this melt I managed to keep it in cupola by floating it, and poured all my work in good shape. I call it we melted 1,600 pounds iron with 210 pounds coke.

JOHN W. MURKLAND.

---

Placing a negative on paper prepared in the ordinary way for blue prints, then exposing them to sunlight in a manner similar to the exposure of a tracing and paper in a blue printing frame, and washing the paper in the same way as any ordinary blue prints, will produce an exceedingly pleasing impression or picture, which will be precisely similar to that of a photograph from the same negative. A picture thus produced will be of a bluish tint on white ground. Many manufacturers of machinery or specialties use this method to advantage for the purpose of illustrating their productions.

---

Bement, Miles & Co., Philadelphia, Pa., have recently brought out a new machine designed expressly for planing the valve and steam chest seats of locomotive cylinders. The table is so made as to be locked in three positions, 90 degrees apart, so that shifting of the work is not required. The four surfaces of the seat for steam chest can be planed at a single setting, as well as the ports.

---

It is a fact as well settled as need be that the highest skilled mechanics are found in those places that offer the best inducements for living pleasantly. A wise man, looking for good machinery, will seek it in a pleasant town or city, because he knows that good mechanics are there to make it.

AMERICAN MACHINIST

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PUBLISHED WEEKLY
BY
**American Machinist Publishing Co.**
**96 Fulton Street, New York.**

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
J. G. A. MEYER, } Associates.
FRED J. MILLER, }

## Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale. We give no premiums to secure either subscribers or advertisers.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once.*

## Subscription.

$2.50 a year in advance, postage prepaid in the United States, Canada and Mexico.
$3.50 a year to Other Countries, postage prepaid.

## Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

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Publishers' Agents, New York.
**The International News Company,**
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NEW YORK, MAY 19, 1888.

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## The New Dynamite Cruiser.

At Philadelphia the other day, there were launched two vessels, one of which, in particular, the dynamite cruiser, will, if anything like the expectations of her designer and the Navy Department are realized, bring about the second revolution in naval warfare, caused by American enterprise and ingenuity.

It is in entire accordance with what might be expected of the United States, that they should, when finally taking steps to place themselves upon something like an even-footing with other countries in the matter of naval equipment, choose to do it by an entire departure from the ideas followed in the building of other navies, and to depend for success upon new applications of science and original inventive talent, rather than merely follow the lead of other countries and attempt to build more and larger floating forts than any yet built, plate them with heavier armor, and equip them with more powerful guns—a competition in which that nation must always lead which is prepared merely to spend the most money for its protection, and in which science and inventive talent play a comparatively small and unimportant part.

Those who are familiar with the results attained at the testing of the dynamite guns can have little doubt as to the efficacy of such guns in naval operations if it be found that the vessel which carries them can be brought within their comparatively short range before being destroyed by the powerful guns of modern iron-clads—a problem which is yet to be solved, and in the solution of which the high speed (20 knots) and the light draught (8½ feet) are expected to play an important part by enabling her to choose her own position for operations. We have little doubt, however, that if it be found necessary or important to throw the dynamite shells to distances greater than one mile, guns will be constructed to do it.

The plan of having the guns immovably fixed upon the deck, so that the vessel must be steered into position to fire them, is a novel one, the success of which is somewhat problematical, especially when it is remembered that a vessel presenting her broadside for a mark, if 300 feet long, would at a distance of a mile subtend an angle of about 3° only, so that if an effort were made to strike her amidships a variation of little more than 1½° in position either way at the moment of firing would render the shot useless.

However the launching was very successful, and we shall, in the course of a few months, probably know just what can be done with her, and in future constructions there will be ample opportunity to correct any defect which may be found to exist.

One of the daily papers gravely announces that "the launching of the vessels was under the direction of Secretary Whitney, although the builders put forth every possible effort in making it successful"—as if the efforts of the builders was a matter of secondary importance, and upon the "direction" of the Secretary mainly depended the success of the launch.

## Important Discoveries.

There is something particularly fascinating in saving fifty per cent. in some process or combination of processes. Twenty-five per cent. used to be thought fairly good, but it is hardly worth speaking of in these times. And in setting forth the possibilities of enormous saving there is generally evidence of startling discoveries having been made. We are moved, just now, to the above by noting, recently, the lengthy prospectus of a company controlling certain processes for pulverizing coal, and burning it, the prospectus being published in the reading columns of the daily press, probably as a paid advertisement. In this the discovery is set forth that "coal, in its natural state, yields results only one-half of that which it can be made to produce if used after the creation of gas." The context shows that the "results" referred to are to be measured by the heat utilized, and the "discovery" is in the direction of quite upsetting the conclusions of experts, who, for some very common purposes, believe they have succeeded in utilizing about eighty per cent. of the heat of coal.

Then, again, we learn that "in locomotives * * * not over twenty-five per cent. of the heat is now made available." We suppose this means available for making steam. Here, again, is an important discovery. Not many master mechanics will admit that their boilers are averaging less than the evaporation of six pounds of water per pound of good coal burned, and they will be equally surprised to learn that it would be possible to evaporate twenty-four pounds of water with the same quantity of coal, if all the heat was utilized. Several other important "discoveries" are duly set forth, but the foregoing must suffice.

There are, beyond question, certain processes in which a great saving would, and does, result from using gaseous fuel. And by the aid of a vivid imagination a mixture of pulverized coal and air may be considered gaseous fuel. But in order to set forth the fact that gaseous fuel is superior for some purposes, it is hardly necessary to make sweeping assertions that those conversant with the matter are sure to see the fallacy of.

It may be reassuring to those who, without having studied the subject, have been led to believe that they are getting materially more than fifty per cent. of the calorific effect of the coal they buy, to know that the prospectus referred to is not published in the interest of manufacturers of the appliances alluded to, but by those who are anxious to give away, for a few dollars, stock which possesses, in the language of the prospectus, "the potentialities of profit beyond the dreams of avarice," whatever that may mean.

## Profiting by the Experience of Others.

In most instances, the fortunate inventor reaches success through profiting by the failures of others. The successful man is the one who, by reading and observation, knows of the success and failures of others—particularly the failures, so far as they are made public. The man who essays to go along without profiting by the experience of others is sure to travel a long road, with the probability of getting nowhere in particular.

This is not only true of the inventor, but of every man engaged in mechanical pursuits. Anything that shows to a mechanic in Maine better practice in California, or elsewhere, is a help he is entitled to, if he can get it—and he generally can in these days, if he is disposed to read.

But it is a fact that in these times, when there is so little excuse for ignorance, methods are employed in large and in small shops that have been demonstrated wrong in a hundred instances. There is no law that will compel a man to read and observe. Those who do not follow current progress sharply generally find out, when it is too late, what others are doing.

Many a man has proved himself a failure through lack of investing twenty dollars a year in the direction of finding out what others are doing. It is immaterial whether one is a business man or a workman—so called. The world will not wait for him in either case. And in either case, if he assumes the ability to keep abreast of the times without help from others, he is sure to get left behind.

One of our contemporaries, struck with the mania for statistics, allows for a family of four, three pairs of shoes a year, at a total cost of $4.50. Just exactly how four persons are to wear three pairs of shoes is not explained.

The latest of all trusts is the farmers' trust. And, truth to say, with them it has come to be, in the main, a matter of self-defense. With one or the other of the great combinations reaching out to affect the cost of everything they buy, there seems to be nothing for the farmers to do but combine to regulate the price of what they have to sell. If there is no way to prevent combination to regulate prices of part of the products of the country, then combination must become universal; when this time comes the trust will have lost some of its flavor.

## Literary Notes.

PRACTICAL HINTS FOR DRAFTSMEN. By Prof. Charles William MacCord.

The leading object of this work is to explain various modes of representations which are not strictly based on the principles of descriptive geometry. The aim of these hints is to suggest to the draftsman slight violations of the rules of projection, enabling him, if possible, to supply the workman with better and clearer drawings than those made in strict accordance with the true principles. No fault is found with descriptive geometry; on the contrary, it is plainly stated that the draftsman should be master of the principles of his science; but it is also asserted that in the practice of his art he should not be their slave, as no one thing is more fatal to practical efficiency than the strict formalism which subordinates the end to the means, allows no exercise of discretion, and binds the draftsman to the observance at all times of inflexible rules. The author gives a number of examples, selected from practice, and explains in each case the particulars in which the rules of descriptive geometry are violated. The author does not attempt to do the impossible thing—such as to state rules which shall guide the draftsman in all cases, and prevent him from carrying these violations beyond reasonable limits—but a great deal is left to the good judgment and ingenuity of the draftsman. These hints are arbitrary suggestions, and, like all arbitrary measures, may meet with considerable opposition. No doubt there will be draftsmen who will insist on following the true principles of descriptive geometry at all times, and reject the hints given; others may follow them only to a small extent, while a number may accept and follow all of them. We ourselves take most decided exceptions to some of the professor's hints and modes of representation, although there are many excellent points brought out in the book. Any difference of opinion that may arise should not detract from the value of the work. It is clearly and vigorously written, and no one can mistake, or be led into error, by any of the author's statements. Young men and mechanics, who are learning practical drawing with the intention of entering the drawing room, and who are already acquainted with the principles of projection, will do well to read this work carefully, and become acquainted with topics on which, often, earnest discussions arise in the drawing room, and with which young men should be familiar before entering it. The chapters on free-hand drawing or sketching, and the description and use of tools, will be found to be interesting and profitable reading. The price of the book is $2.50; it is published by John Wiley & Sons, New York.

## QUESTIONS AND ANSWERS.

***Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.***

***Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.***

(250) C. R. K., Ilion, N. Y., asks: Why is it, and why is it necessary, that one stroke of a locomotive air pump should be quicker than the other? *A.*—It is not necessary, neither is the pump designed so that the motion of the piston in one direction shall be quicker than the motion of the same in the opposite direction. This alternate quick and slow motion of the piston is the result of its having more work to do in one direction than in the other.

(251) C. G., Germantown, Pa., writes: Will you please explain the details of the Westinghouse air brake, valves, etc., or give the name of some book where it is explained? *A.*—Write to the Westinghouse Air Brake Company, Pittsburgh, Pa., for a catalogue. 2. Explain why the lead is constant in the lifting link valve gear in a locomotive

*A.*—The lead in a lifting link is not constant; it is constant only in a stationary link. See AMERICAN MACHINIST, Oct. 2, Nov. 6, and Nov. 20, 1886.

(252) W. E. H., Brooklyn, N. Y., asks: Can a steel disk wheel, ten feet diameter, 4 inches in thickness at the center, and tapered to ¼ inch at the periphery, be run with a velocity of 6,000 feet per minute, providing the steel can be made with a tensile strength of 75,000 per square inch. *A.*—Yes. Be careful to obtain homogeneous steel.

(253) W. G. C., Charleston, S. C., asks: Please give me the cause of the humming noise in the furnace of some steam boilers, usually called "back draft." *A.*—It is a difficult matter to state the cause of this noise; sometimes the theory is advanced that the noise is caused by the violent combination of oxygen and hydrogen, the buzzing being an aggregation of minute explosions.

(254) W. M. M., Marietta, Ohio, writes: Please give me some points in regard to drafting with India ink on tracing cloth. I have some difficulty in making a mark distinctly on the varnished side of the cloth; it seems to be oily, so that a mark will not always follow the pen, and I cannot make as fine a line as I want to do. Where is the trouble? *A.*—With a dry linen rag dipped into finely powdered chalk, rub the glazed side of the tracing cloth, until some of the gloss is taken off the surface; then with another linen rag or brush, wipe or brush off all the remaining chalk. This treatment will remove all the difficulty you have experienced.

(255) J. L. G., New York, asks: If a ¾ inch water pipe leading from a tank or from the street with a pressure of about 30 pounds to the square inch into a boiler or a jacket kettle with a ¾ inch overflow or outlet, what pressure, if any, is in the boiler or kettle? *A.*—Neglecting the weight of water, the pressure in the boiler will be equal to pressure at the junction of the boiler and the pipe leading into it. If the pressure at this point is 30 pounds per square inch, then the pressure in the boiler will also be equal to 30 pounds. If the pressure at the other end of the pipe is 30 pounds, and the pipe very long, the friction of the water in the pipe will reduce the pressure in the boiler.

(256) C. F. R., Troy, N. Y., writes: What will be the effect on the valve movement and cut-offs by disregarding the offset in the rocker arm, when, according to the principles Mr. Meyer gives in "Laying Out Link Motion," there should be offset in the rocker arm? *A.*—Disregarding the offset in rocker arms will give to the valve a movement which is not symmetrical, and it will also affect the position of the saddle pin on the link. Although we do not advocate disregarding the offset in rocker arms, we must admit that in many locomotives the effect produced by straight rocker arms, when these should have offset, will be so slight as not to be appreciable.

(257) C. S., New York, writes: We are very much troubled by getting the paper ready for heliographic copies. The paper, which is covered with a thin coat of chemical solution, must be prepared either by hand or imported from Paris. The paper finished by hand is very imperfect: the paper imported from France is prepared by a machine, but it is very expensive. What I would like to know is if machines for preparing rolls of paper for the purpose mentioned are made in this country? *A.*—We believe machines of this kind are made in this country, but they are expensive. Write to any manufacturer of machines for making wall paper, and you will obtain price, and all necessary information.

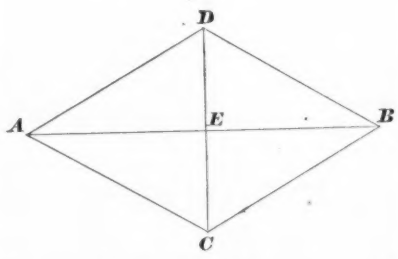
(258) X. Y. Z., Vt., wants to know if there is any way to successfully demagnetize an electro-magnet of a telegraph sounder, which has in some manner become permanent, to a slight extent, or does not immediately lose its magnetism on the circuit being broken; that is, without putting in new cores. *A.*—The softest iron will retain traces of magnetism (residual magnetism), but it should not be sufficient to cause trouble unless the iron is unsuitable. You can remove this charge and perhaps render the iron less susceptible to another, by annealing the cores as you would a piece of steel. We suggest, however, that you first make sure that your adjusting screws are set right, so that the armature does not come in contact with the cores. If contact does take place it will greatly increase the residual charge and make the magnet slower to let go.

(259) M. A. P., Chicago, Ill., writes: Enclosed please find a clipping from Carter Harrison's letter from India to one of the Chicago papers. In it you will notice a reference to a wrought-iron column over seventy feet long and eighteen inches diameter. This column is situated two miles from Delhi, India. I have been wondering whether it was really wrought-iron, or merely cast-iron, and how it compares with work of this age if it is wrought. *A.*—Since we have not seen this column we are not in a position to contradict Mr. Carter Harrison, nor can we express any opinion as to its merits. 2. According to the answer to Question 80 in the AMERICAN MACHINIST, the stress on the rope = 9,406 pounds. Applying this method to finding the stress in struts, we have

$$\frac{150.5 \times 500}{4} = 18{,}812.5, \text{ or}$$

twice as much stress as on the rope. This formula is found in all the books on trusses at my command. I also see the logic of your answer, and do not doubt its correctness. But why this difference? *A.*—In order to enable our readers to understand this answer we reproduce the cut given in answer to Question 80, and will also state the problem, which our corresponent indicates by a sketch in his letter. Let *A D* and *B D* represent two struts, *A B* the span, equal to 300 feet, and *D E* the rise, equal to 4 inches: the load at *D* is 500 pounds; what will be the stress in each strut? Our answer to Question 80 plainly indicates that the stress on the line *A D* will be as much greater than the force represented by the line *D C*, as *A D* is longer than *D C*. Consequently we must first find the length of *A D*. The manner of determining this length is also explained in the answer referred to; and was found to be 150.5 feet. Therefore the stress on the strut *A D* or *B D* will be

$$\frac{150.5 \times 500}{8} = 9{,}406.25 \text{ pounds.}$$




In answer to Question 80 we find the stress on the rope to be equal to the same amount, namely 9,406.25 pounds, and there is no such difference as our correspondent found. We may also obtain the same results in representing the forces by a triangle *A D E*. Placing a load of 500 pounds at *D*, it must be evident that the strut *A D* has to resist one-half of this load, namely 250 pounds. Hence in our triangle *A D E*, the line *D E* will represent 250 pounds, and the force represented by the line *A D* will be just as much greater than the force *D E* as the line *A D* is longer than *D E*. Hence we have

$$\frac{150.5 \times 250}{4} = 9{,}406.25 \text{ pounds,}$$

which is the stress on the strut *A D*. To be candid, we believe our correspondent has fallen into an error through careless reading.


## BUSINESS SPECIALS

*Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.*

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See special ads. pages 15 and 16 Lodge, Davis & Co.

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Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Artesian, salt and oil well pumps; sucker rods and deep well supplies; wrought-iron tubing and steam pipe. Hardwicke & Ware, Buffalo, N. Y.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See May 5, p. 14. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Robertson's damper regulator; no diaphragms, springs or packing; the cheapest good regulator in market. Hine & Robertson, 45 Cortlandt st., N. Y.

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How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

Randall's copper-tipped hammers are something that every machinist should have; ask your dealer to show you one, and if he does not keep them, write to Montgomery & Co., 105 Fulton st., N. Y.

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The Dieble Mfg. Co., Philadelphia, Pa., mfrs. of the Challenge emery grinding and polishing machinery, invite correspondence with all needing this class of machinery. Catalogues and prices on application.

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James D. Cardell & Co., 1900 Passyunk ave., Philadelphia, Pa., boiler makers, manufacturers of tanks, stacks, and all kinds plate iron work; coils of wrought-iron pipe for ice machines, blast furnaces, paper mills, dye houses, etc., also coil boilers.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price, $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

The series of articles by J. G. A. Meyer, on "Practical Drawing," now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including April 7, 1888 issue 47 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton street, New York.

"Modern Locomotive Construction," by J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 61 articles have thus far appeared up to and including the March 31, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.


## MANUFACTURES

A. J. Love expects to build a foundry at Durant, Miss.

A. W. Cook will build a furniture factory at New Berne, N. C.

J. Studebilt will start a wagon factory at Choctaw Corner, Ala.

An iron foundry will be started at Camden, Ark., by Edward Clifton.

The Prescott Automatic Car Brake Company has been incorporated at Chicago, Ill.

The Birmingham (Ala.) Safe and Lock Company will erect an electric light plant.

The Columbus & Western Railroad Company will build a roundhouse at Birmingham, Ala.

T. Paterson & Sons are increasing the capacity of their foundry and machine shop at Albany, Ga.

The Sherman (Texas) Iron Works have been purchased by J. W. Dickson. It is expected that he will enlarge the works.

A company has been organized at Tuskaloosa, Ala., known as the Tuskaloosa Electric Light and Gas Company. The proposition is to erect an electric light plant.

A company has been organized at Nashville, Tenn., known as the Nashville Jenny Electric Light and Power Company. It is expected the company will begin operations at once.

The Atlantic Machine Works, Boston, Mass., were recently burned, involving a loss of $150,000. The fire started in the pattern shop, and is believed to have caught from an electric light wire.

The Dixon Crucible Company, of Jersey City, have changed the name of their "Graphite Smear Grease" to "Graphite Pipe-Joint Grease," as better expressing the most important use made of it.

The Government is adding new tools to the Portsmouth Navy Yards, having recently ordered a triple radial drill and a suspended drill from the Universal Radial Drill Company, Cincinnati, Ohio.

New water-works or the enlargement of existing works are contemplated at Milton, Ore.; Montrose, Col.; Wichita, Kan.; Bushnell, Ill.; Orleans, Neb.; LaGrange, Tex; Tallapoosa, Ga.; Tarboro, N. C.; Clarksburg, W. Va.

An iron foundry is to be started in Livermore Falls, Maine, by A. B. Jewett and Ernest Keene. The building will be 18x32, and an engine, boiler and engine lathe have arrived. The foundry is expected to be ready for work in about a month.

John Klein, Oil City, Pa., has recently built a pump, said to weigh more than 100 tons, for the oil line from Lima to Chicago. It is expected that this pump will force oil the entire distance—210 miles—at the rate of 350 barrels per hour.

McCoy & Saunders, 26 Warren street, New York, are agents for the sale of the Gates solid wrench. The main bar and handle of this wrench are in one solid piece, avoiding the weakness of a wooden handle. Other features of this wrench may be seen by consulting the catalogue.

The silk mill in Guilford, Maine, has been leased to the Singleton Silk Manufacturing Company of New York for two years. This concern will start up the works on or before May 1, with as many hands as can be engaged by that time. It has plenty of work and proposes to pay good wages.

D. Saunders' Sons, Yonkers, N. Y., have issued their 1888 catalogue of pipe-threading machines, tapping and drilling machines, taps, reamers, tongs, cutters, pipe vises, etc. It is a large paged catalogue, very fully illustrated, and contains brief descriptions of machines and devices for steam and gas fitters' use.

The Hazelton Boiler Company, New York, have recent orders for two 250 horse-power boilers to Washington Gas Light Company, Washington, D. C.; two 75 horse-power to Holyoke Envelope Company, Holyoke, Mass.; one 215 horse-power to the Farrel Foundry and Machine Company, Ansonia, Conn.; one 215 horse-power (second order) to E. R. Carhuff, Newark, N. J.

The Covered Tube Cable Railway Company, 186 Remsen street, Brooklyn, N. Y., have printed a pamphlet written by their Chief Engineer, A. H. Mathesius, in which the cost of the different systems of street car propulsion is compared. Mr. Mathesius has spent a good deal of time investigating this cost from propulsion by horses up to the electric motor, and makes complete comparisons. The pamphlet is, we believe, intended for distribution amongst those interested in the subject.

R. H. Brown & Co., manufacturers of mechanics' tools, are making preparations for the erection of a large new factory in connection with their present building on Ashmun street, New Haven, Conn., for which R. G. Russell is making plans. The building will be two stories high, with basement, 40x100 feet, and there will be an addition to another building, 30x40 feet. The building will have an elevator and fire-proof vauts, with concrete floors, for the safe keeping of valuable tools, etc.—*Connecticut Real Estate Record.*

W. H. Moore, the extensive manufacturer of bed slats and spring-bed material at Gardiner (Maine) received his patent on his new excelsior machine March 20, 1888. This machine is 50 feet long, and has ninety-five cutting knives, and will be of a capacity to turn out four to five tons of excelsior daily. The machine comprises eight sections. Two sections have been worked part of the time during the past year, and an excellent quality of excelsior has been produced. In a few weeks Mr. Moore's arrangement will be complete for running the entire machine constantly. It is adapted to utilize the waste of saw mills, and spruce wood is found to make a most excellent quality of excelsior. This new invention, which is considered a very valuable one, will be the means of establishing another prominent industry in Gardiner, and probably in other sections of the State.—*Industrial Journal.*

The Kansas City [Mo.] *Commercial* says: "All the leading foundries in the city are running full time, and some of them find it necessary to run into the night in order to keep pace with their orders. Never before in the history of Kansas City has there been so great a demand for castings for both buildings and cable lines. The latter demand is large, and the forces of men employed in satisfying it is being constantly increased. Prices are firmer as the season advances, although the bulk of the contracts for the year's work has already been let. There is no doubt that there is a good opening here for much more capital in this channel than is at present employed. All the foundries report prompt payments, the bulk of the jobs being taken on the basis of cash on delivery." And of planing mills: 'The demand for the output of these mills is far below the capacity of the plants here established. A good many mills are working night and day, and even then find it difficult to keep pace with orders. This results in delay to building operations to some extent."

Seaman, Sleeth & Black, Forty-first street [Pittsburgh, Pa.] are now running to their full capacity, and are making some of the largest rolls that have ever been made, both chilled rolls and their patent semi-steel rolls. They have at their works chilled rolls 33 inches in diameter, cast by a new process (for which letters patent are now pending). They claim to be able to make chilled rolls of any size by this process that will give a much better roll than has heretofore been made, besides reducing the risk of cracking and spawling to a minimum. They have in their shop a large number of heavy rolls of their semi-steel brand, among the lot some that require 32 tons of metal to pour each roll. They are now erecting a new, and what they claim will be the largest and heaviest roll-turning lathe in the country—the shears being 28 feet long, 6 feet 6 inches wide, face-plate 6 feet diameter—capable of swinging rolls 72 inches in diameter, all parts being built as strong as their thirty years' experience has shown to be required. They are now running 21 roll turning lathes.—*American Manufacturer.*

### Machinists' Supplies and Iron.

NEW YORK, May 3, 1888.

Iron—American Pig—Prices have been in buyers' favor and are somewhat lower for all grades. We quote good to choice brands No. 1 X Foundry, $19.50 to $20.50; No. 2, $17 to $19; Grey Forge, $16 to $17, and ordinary brands as low as $15 to $15.50.

## WANTED

*"Situation and Help" Advertisements only inserted under this head. Rate, 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.*

Wanted—Men to sell planes, see page eleven.

Young Swede, machinist, wants situation; good vise hand. "John," Jamaica Plain P. O., Mass.

Mech. draftsman experienced on Corliss engine & gen. mach. work wishes position. S. A., AM. MACH.

Situation wanted in New York or Brooklyn by a first-class draftsman on marine engine or general work. H. P. A., AM. MACHINIST.

Situation wanted by a young machinist draftsman of ten years' experience; first-class; best of references. Address A., Box 1182, Fitchburg, Mass.

Wanted—Two or three skillful machinists, also one competent to take charge of small first-class shop in New York city. Address Stephenson, AM. MACHINIST.

Wanted—By an American, a position to take charge of a foundry; is used to handling men, and all kinds of foundry work. Address S. C. G., 59 Downing st., Brooklyn, N. Y.

Wanted—A practical pattern maker to take charge of the pattern department of the Dunkirk Iron Works. Address, stating experience, wages expected, etc. Dunkirk Iron Works, Dunkirk, N. Y.

Wanted—By a young man 19, actually employed as help in machine shop, and having some knowledge of practical drawing, situation in large machine shop to thoroughly learn machinists' trade. B. Y., AM. MACHINIST.

Machinist with good technical education 13 years' exp. in building tools, pumps, marine, stationary, and locomotive engines; in charge of machine department at one of the largest iron furnaces South; energetic; best references. A. J. S., 423 W. 19th st., N. Y.

## MISCELLANEOUS WANTS.

*Advertisements will be inserted under this head a 35 cents per line, each insertion.*

Crescent solid lubricant, clean, durable, cheap; prevents hot boxes. Crescent Mfg. Co., Cleveland.

The Crescent automatic grease cup is adapted to every service. Crescent Mfg. Co., Cleveland, Ohio.

Hard rubber blowing and pressing dies and machinery a specialty. E. O. Chase, Newark, N. J.

Wanted—Parties having machinery specialties to build, to correspond with. BOX 75, AM. MACHINIST.

Wanted—Parties having specialties to manufacture, correspond with Cedar Point Foundry and Machine Shop, Port Henry, Essex Co., N. Y.

Wanted—To correspond with parties having specialties to manufacture, small machinery and pat'd articles. Address "Natural Gas," AM. MACHINIST.

Wanted—Cheap testing machines for cast-iron to give contraction, deflection, and strength; also any other useful foundry tools. Jas. Evans & Co., Gaythorn, Manchester, England.

August C. Christensen, 26 Church st., N. Y., mech. and hydr. engineer. Prepares designs of waterworks pumping stations, drawings of steam pumps, pumping engines, gen. mach'ry and pat. drawings.

Wanted—A 60"x60" planer to plane from 15 to 30 feet, either new or second-hand. If second-hand, must be of modern design and in first-class order. Address Fosdick & Plucker, Sixth and Culvert, Cincinnati, Ohio.

For Sale—One complete set of pulley moulding machinery to make pulleys from 6 inch to 40 inch; one 9 ton cupola; three foundry cranes; one sheet-iron core oven; crane hand ladles from 40 pounds to 7,000 pounds; complete with necessary bales and handles. Address North Star Iron Works, Minneapolis, Minn.


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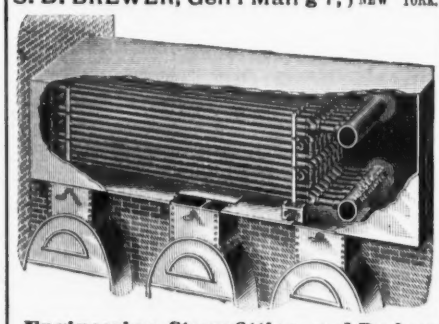

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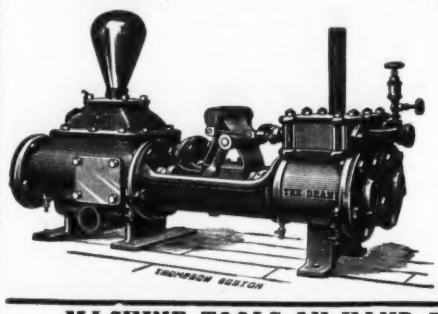

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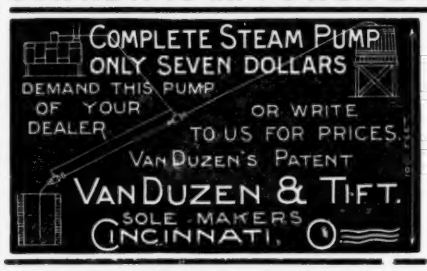


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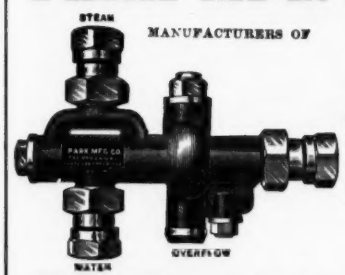


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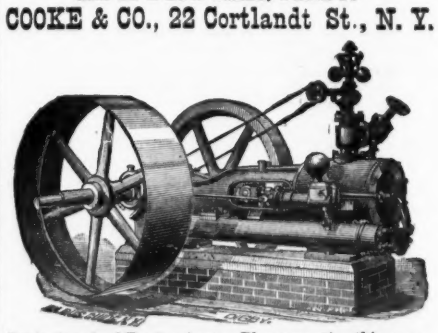

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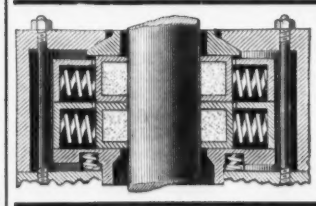

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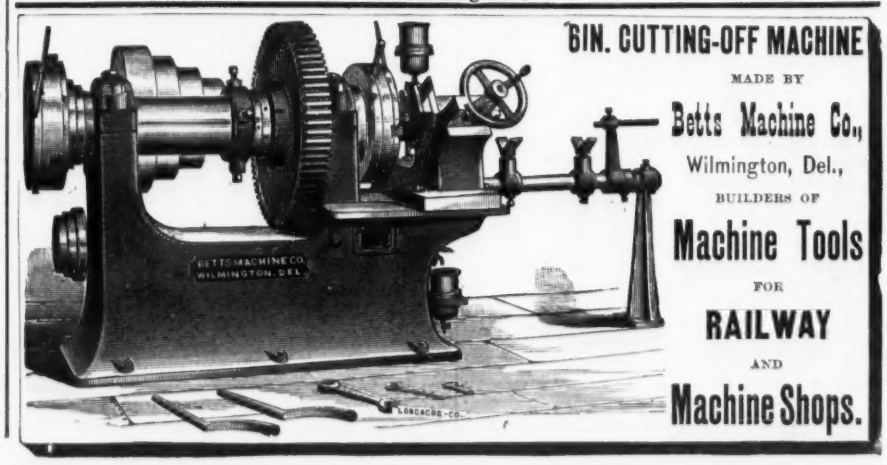


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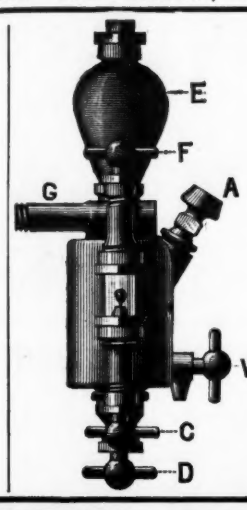


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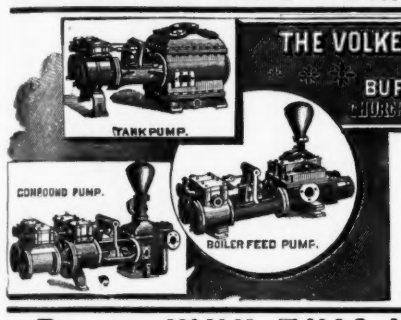


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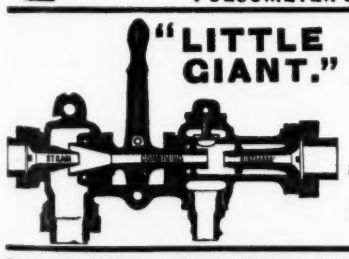

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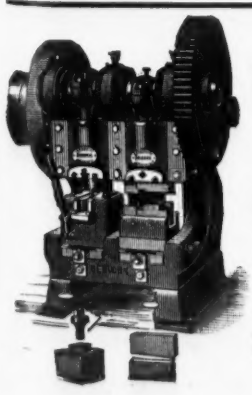

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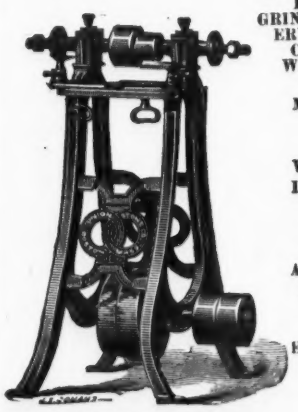

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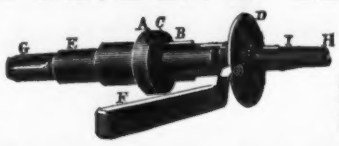


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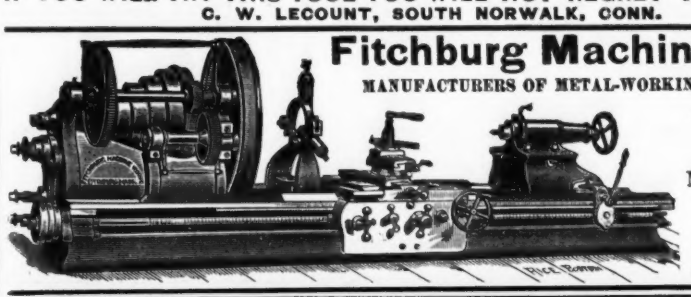

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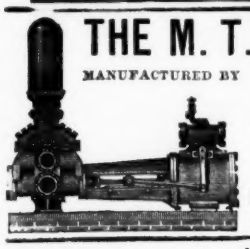

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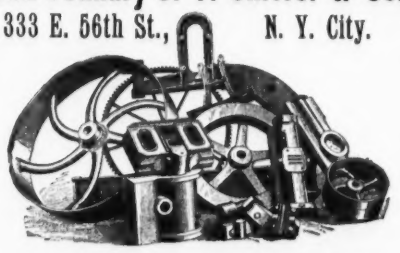

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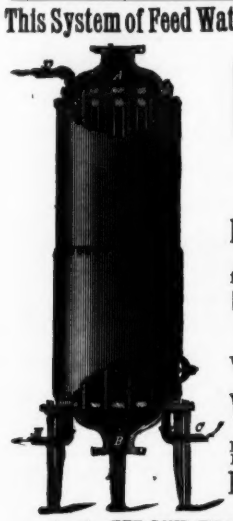

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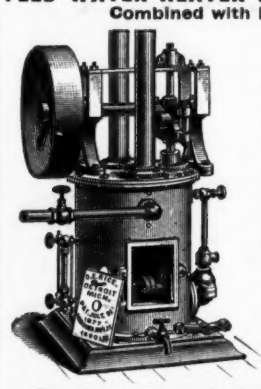

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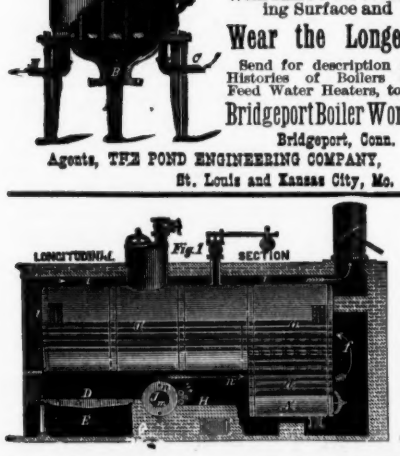


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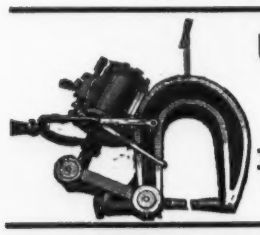

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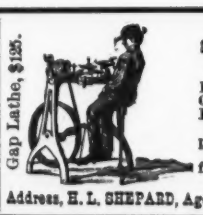


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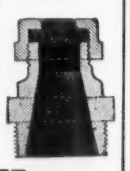

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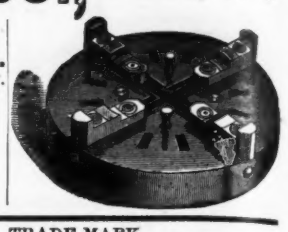
| 15¼ " | 17 " |
| 18 " | 19¼ " |
| 21 " | 25⅞ " |
| 24 " | 28 " |



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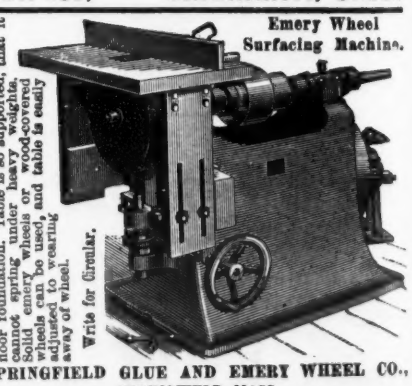

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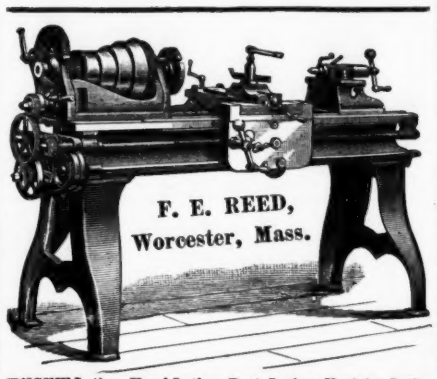


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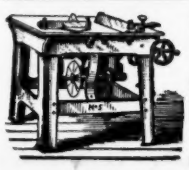

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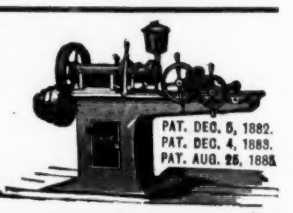


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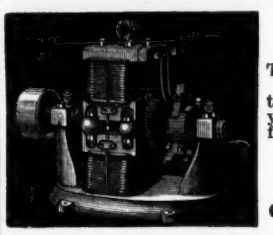

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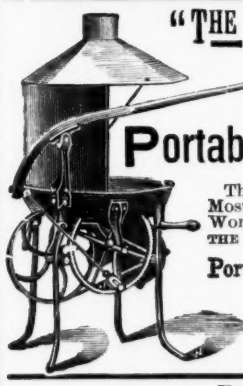

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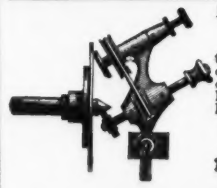

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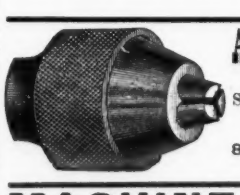

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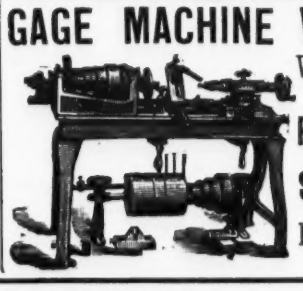

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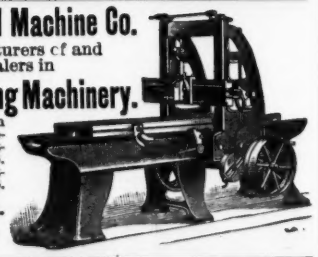

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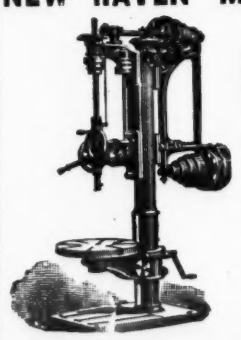

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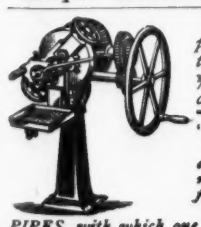

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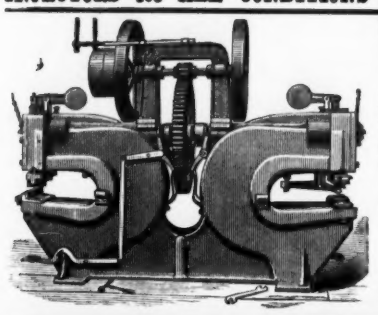

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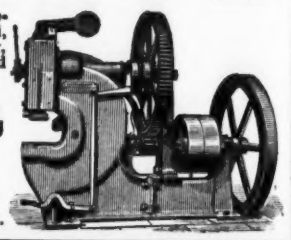

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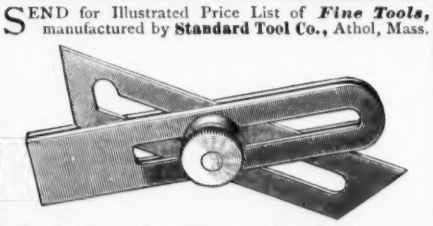

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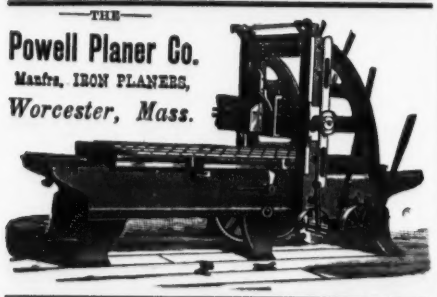

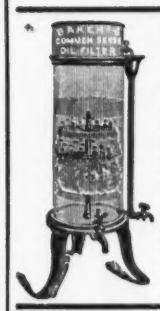


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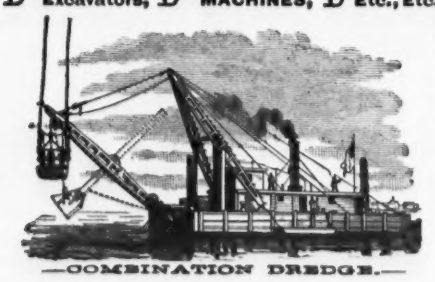

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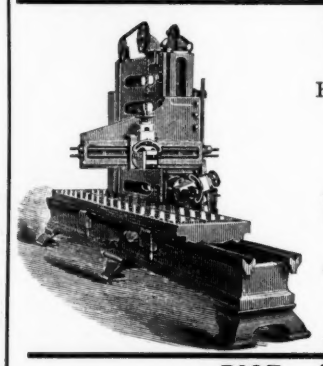

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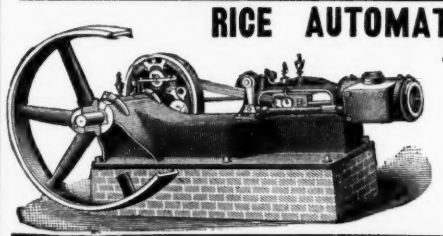

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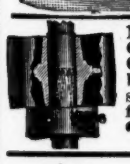

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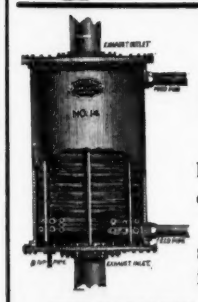

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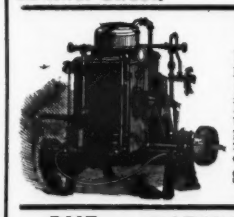

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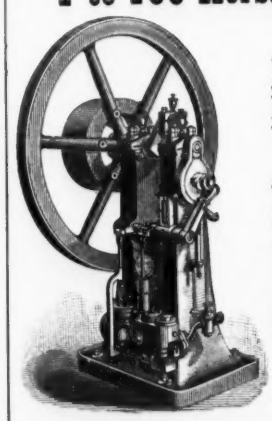

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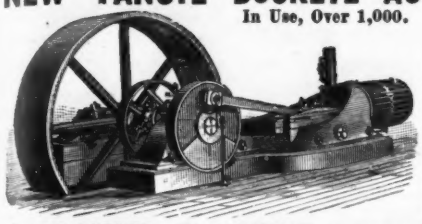

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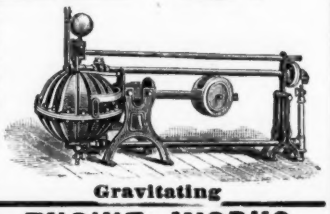

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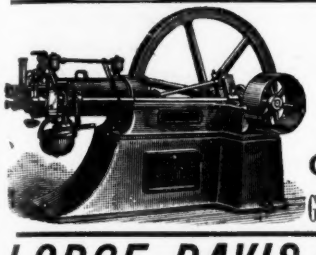

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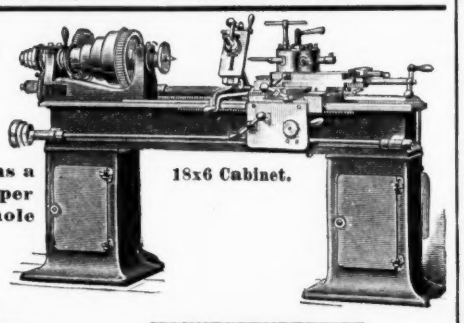

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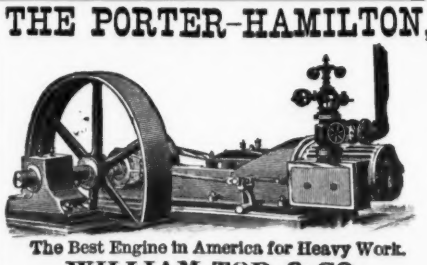

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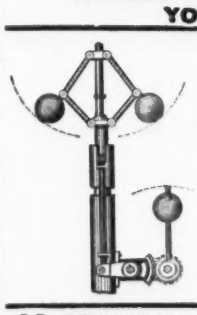

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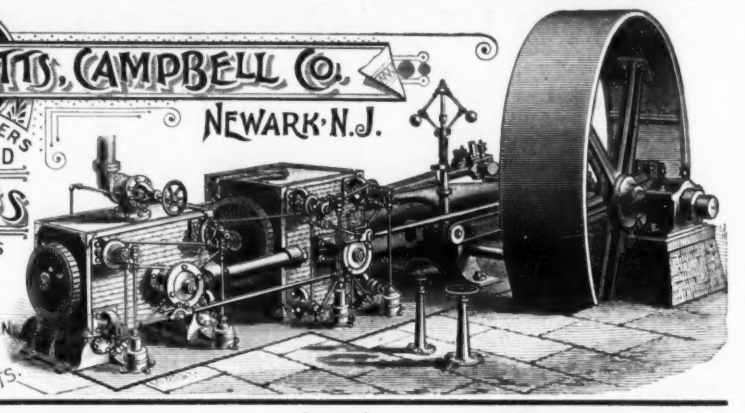

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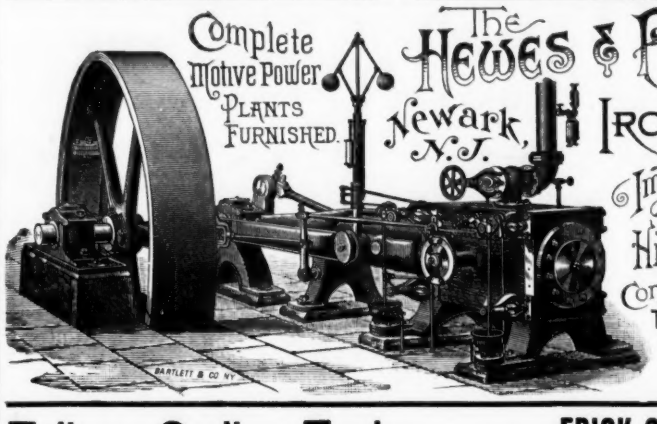

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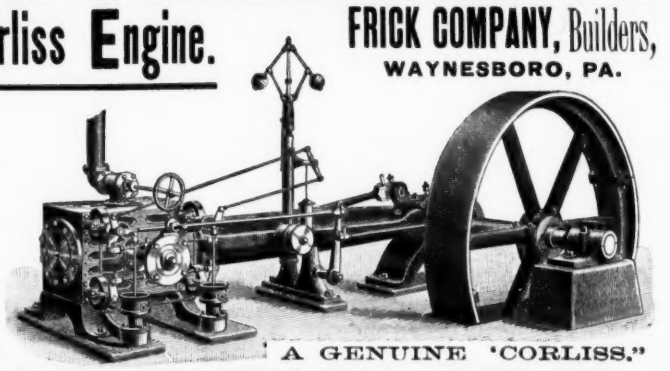

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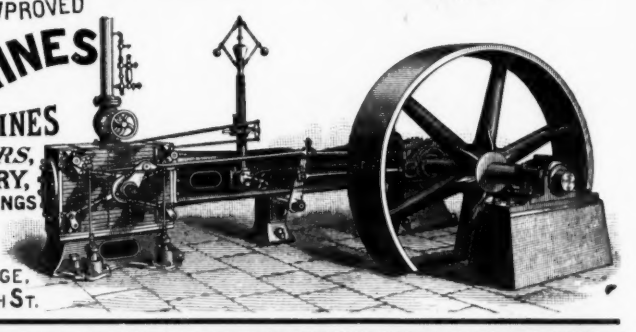

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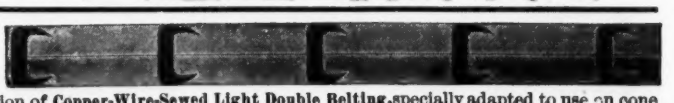

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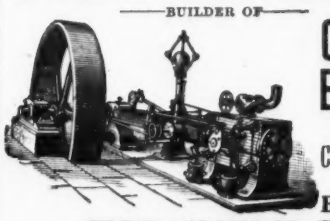

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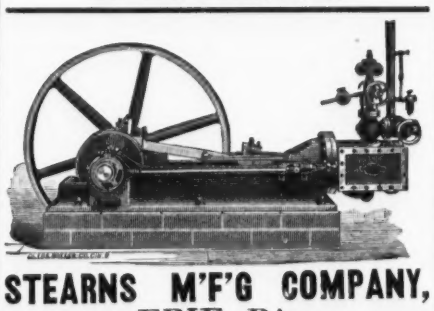

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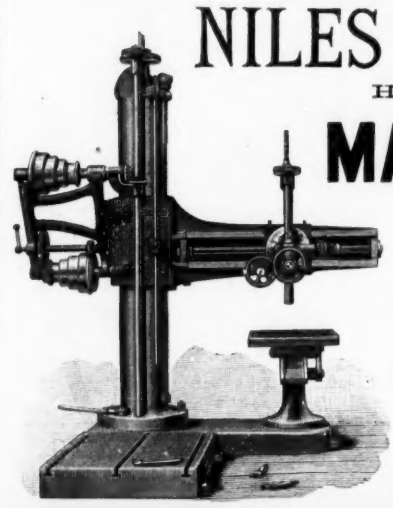

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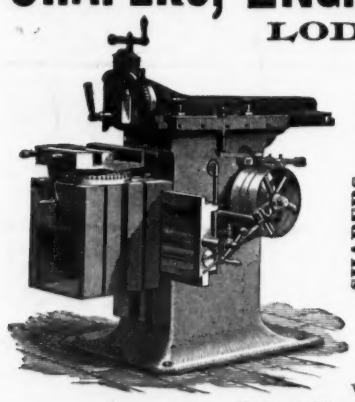

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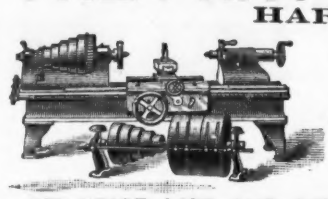

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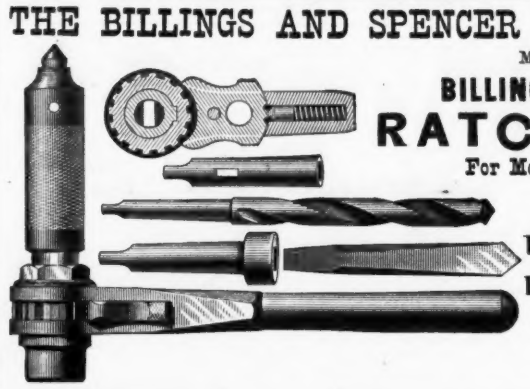

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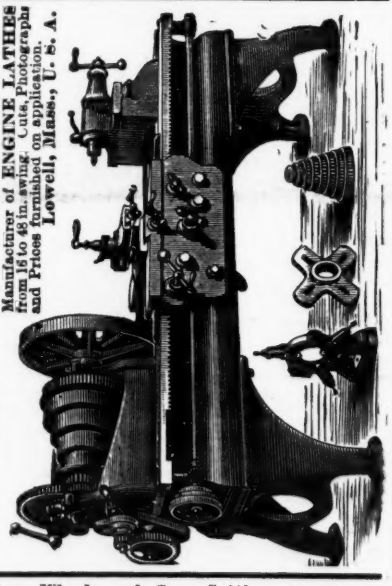

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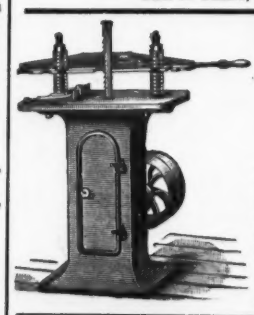

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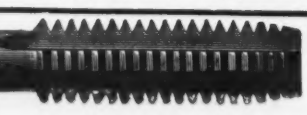

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